

(12) **United States Patent**
McClellan et al.

(10) **Patent No.: US 9,608,382 B2**
(45) **Date of Patent: Mar. 28, 2017**

(54) **HEADER TRANSITION CONNECTOR FOR AN ELECTRICAL CONNECTOR SYSTEM**

(71) Applicants: **Tyco Electronics Corporation**, Berwyn, PA (US); **TE Connectivity Nederland B.V.**, s'Hertogenbosch (NL); **Tyco Electronics Belgium EC BVBA**, Oostkamp (BE)

(72) Inventors: **Justin Shane McClellan**, Camp Hill, PA (US); **Jeffrey Byron McClinton**, Harrisburg, PA (US); **Lieven Decrock**, Roeselare (BE); **Han van het Bolscher**, Tilburg (NL)

(73) Assignees: **TE CONNECTIVITY CORPORATION**, Berwyn, PA (US); **TE CONNECTIVITY NEDERLAND B.V.** (NL); **TYCO ELECTRONICS BELGIUM EC BVBA** (BE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/526,162**

(22) Filed: **Oct. 28, 2014**

(65) **Prior Publication Data**
US 2016/0118751 A1 Apr. 28, 2016

(51) **Int. Cl.**
H01R 13/648 (2006.01)
H01R 13/6587 (2011.01)

(52) **U.S. Cl.**
CPC **H01R 13/6587** (2013.01)

(58) **Field of Classification Search**
CPC H01R 23/688; H01R 13/6594; H01R 13/6585; H01R 13/6587

USPC 439/607.07–607.1
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,899,566 B2 *	5/2005	Kline	H01R 13/514
				439/108
7,485,001 B2 *	2/2009	Chen	H01R 13/65802
				439/607.05
8,016,616 B2 *	9/2011	Glover	H01R 12/585
				439/607.05
8,167,651 B2	5/2012	Glover et al.		
8,419,472 B1 *	4/2013	Swanger	H01R 13/6587
				439/607.07

(Continued)

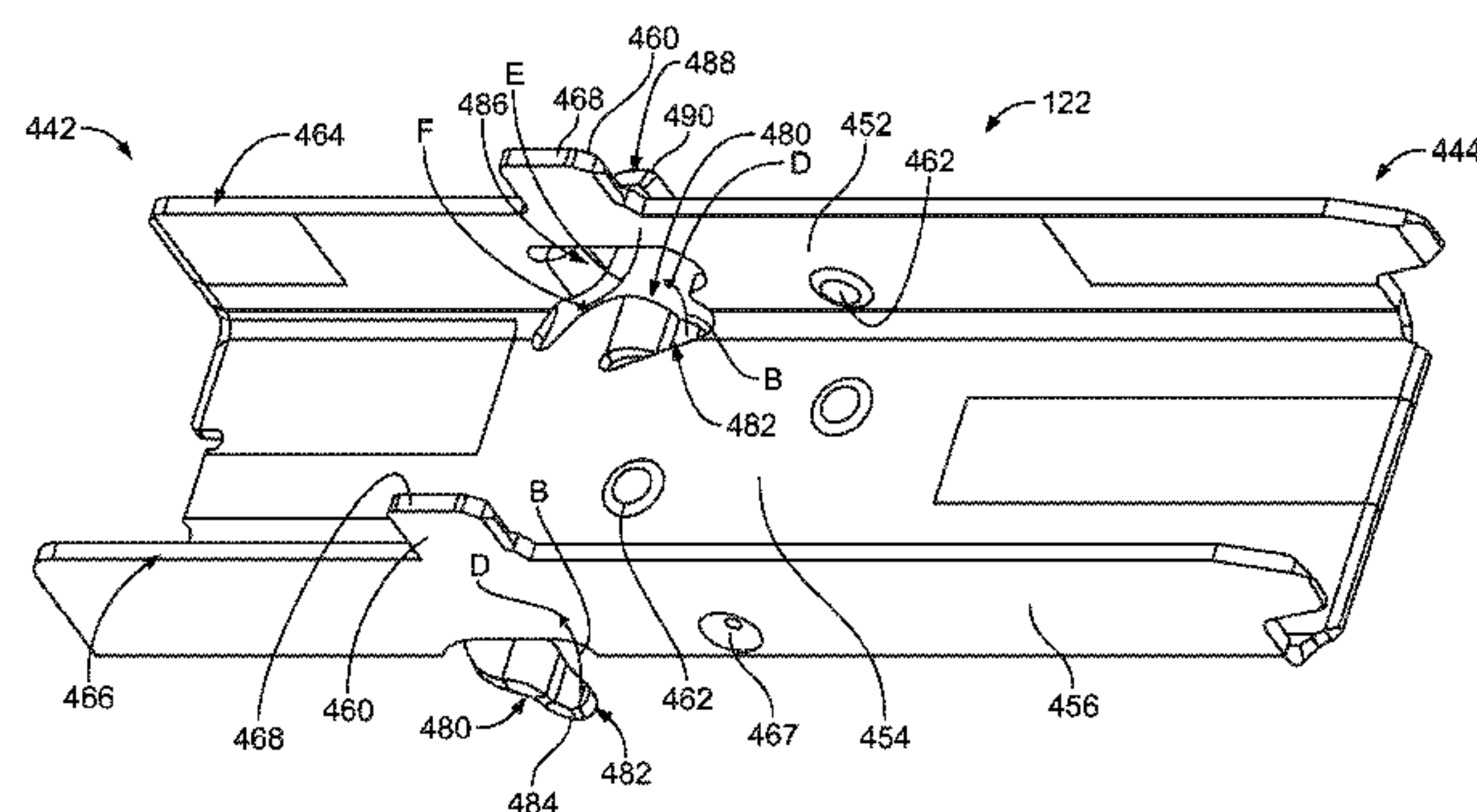
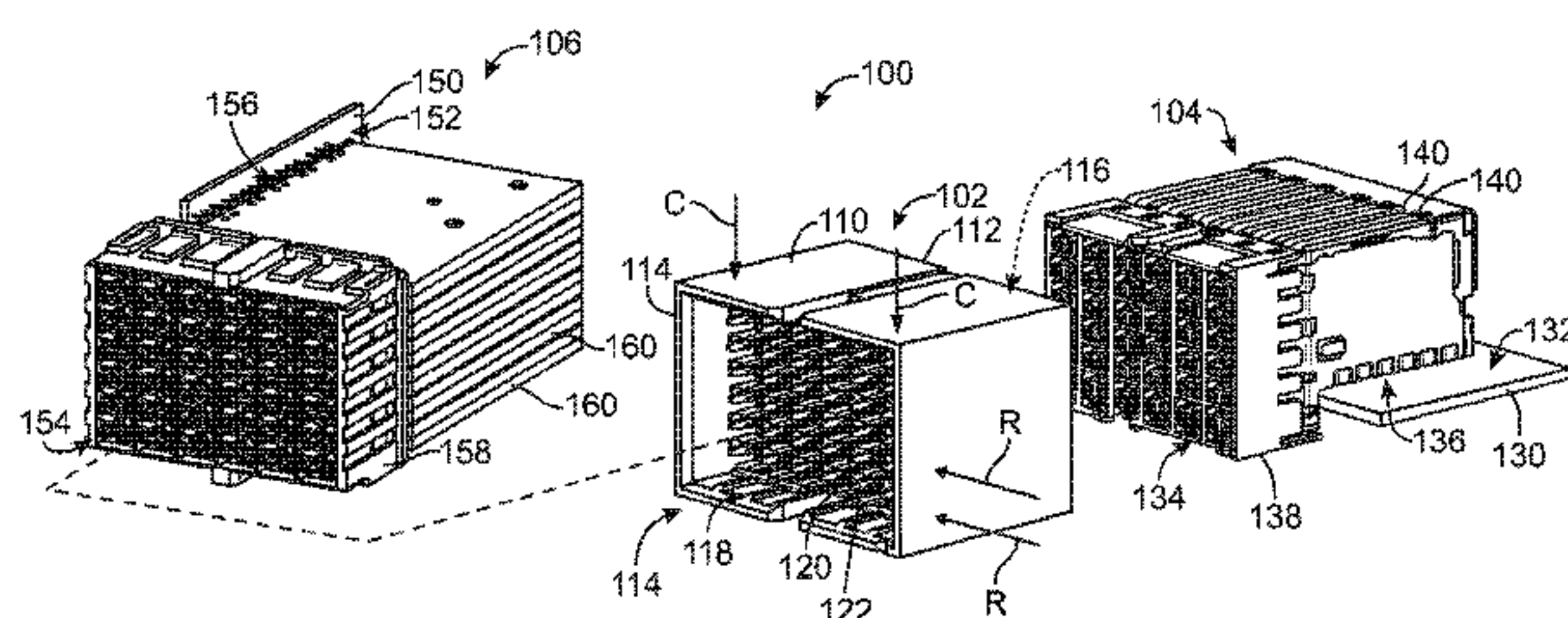
FOREIGN PATENT DOCUMENTS

TW 307240 U 3/2007
Primary Examiner — Abdullah Riyami
Assistant Examiner — Thang Nguyen

(57) **ABSTRACT**

A header transition connector includes a header housing having a separating wall separating a first cavity from a second cavity. Header signal contacts are held by the header housing. The header signal contacts are arranged in pairs carrying differential signals. The header signal contacts have first mating ends in the first cavity for mating with a first receptacle connector. The header signal contacts have second mating ends in the second cavity for mating with a second receptacle connector. Header ground shields are held by the header housing. The header ground shields have first mating ends in the first cavity for mating with the first receptacle connector. The header ground shields have second mating ends in the second cavity for mating with the second receptacle connector. At least a group of the header ground shields are electrically commoned with each other within the header housing.

21 Claims, 11 Drawing Sheets

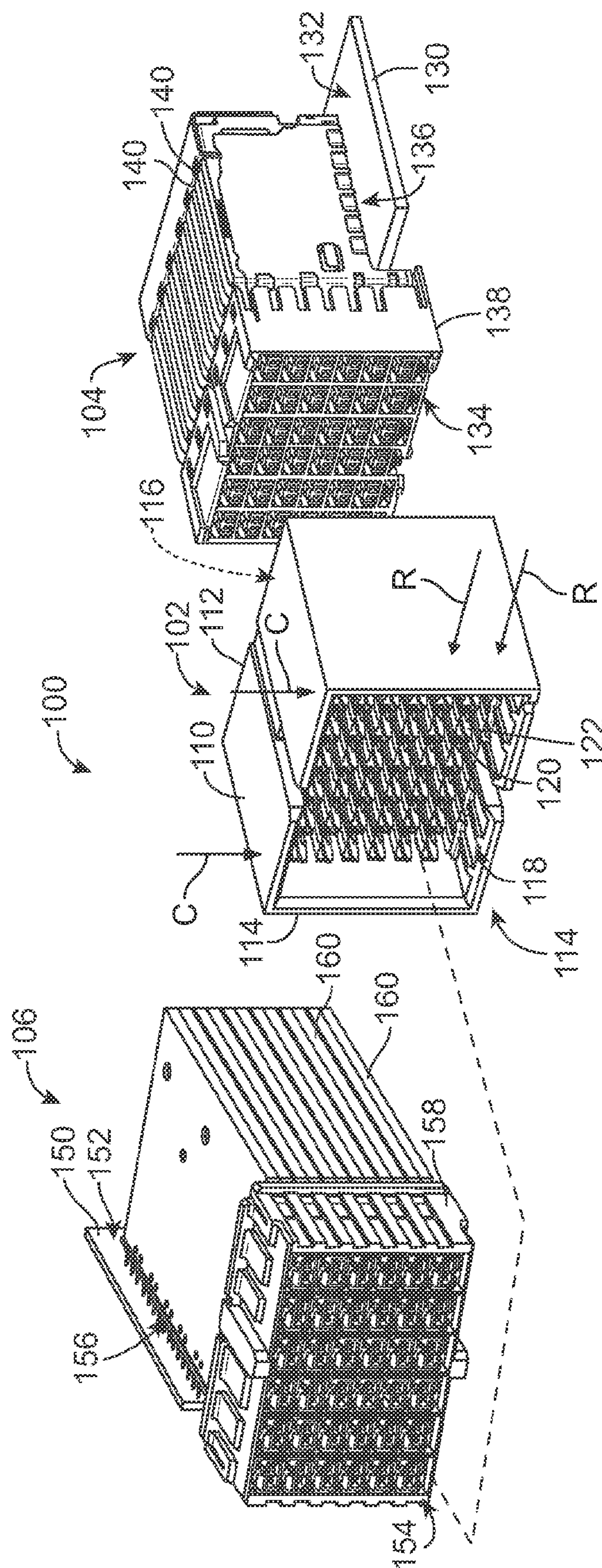


(56) **References Cited**

U.S. PATENT DOCUMENTS

8,430,691	B2 *	4/2013	Davis	H01R 13/6585 439/607.09
8,500,487	B2	8/2013	Morgan et al.	
8,628,356	B2 *	1/2014	Laurx	H01R 12/737 439/628
8,641,448	B2 *	2/2014	Lappoehn	H01R 23/688 439/607.09
8,870,594	B2 *	10/2014	McClellan	H01R 9/22 439/607.05
2011/0143591	A1 *	6/2011	Davis	H01R 13/6587 439/607.27
2014/0051295	A1 *	2/2014	Westman	H01R 13/514 439/626
2014/0106583	A1 *	4/2014	Vino, IV	H01R 13/6587 439/95
2014/0120770	A1 *	5/2014	Nguyen	H01R 13/6585 439/607.34
2015/0031238	A1 *	1/2015	Davis	H01R 23/688 439/607.05
2015/0104977	A1 *	4/2015	Hamner	H01R 12/716 439/626
2015/0236450	A1 *	8/2015	Davis	H01R 12/71 439/78

* cited by examiner







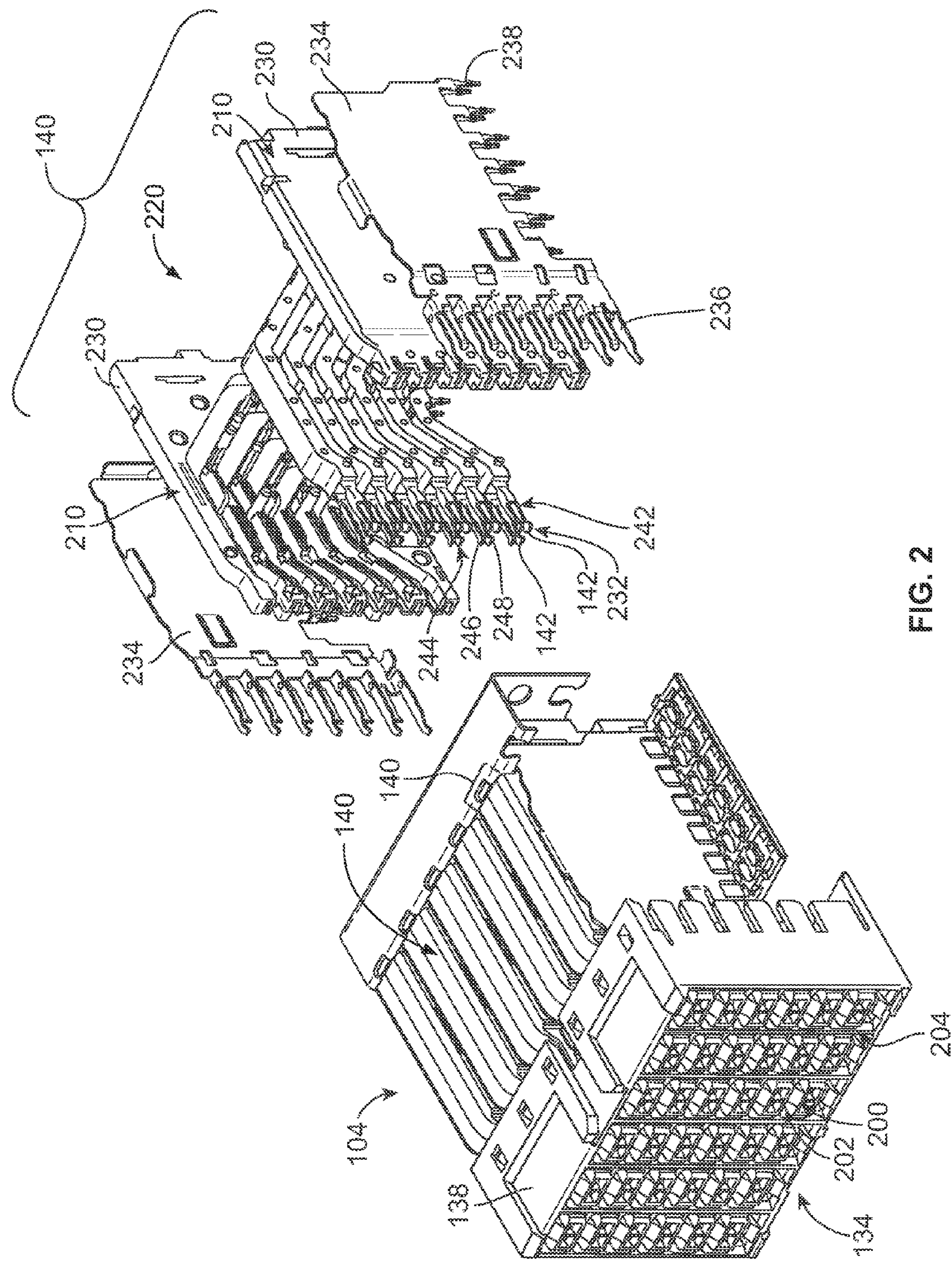
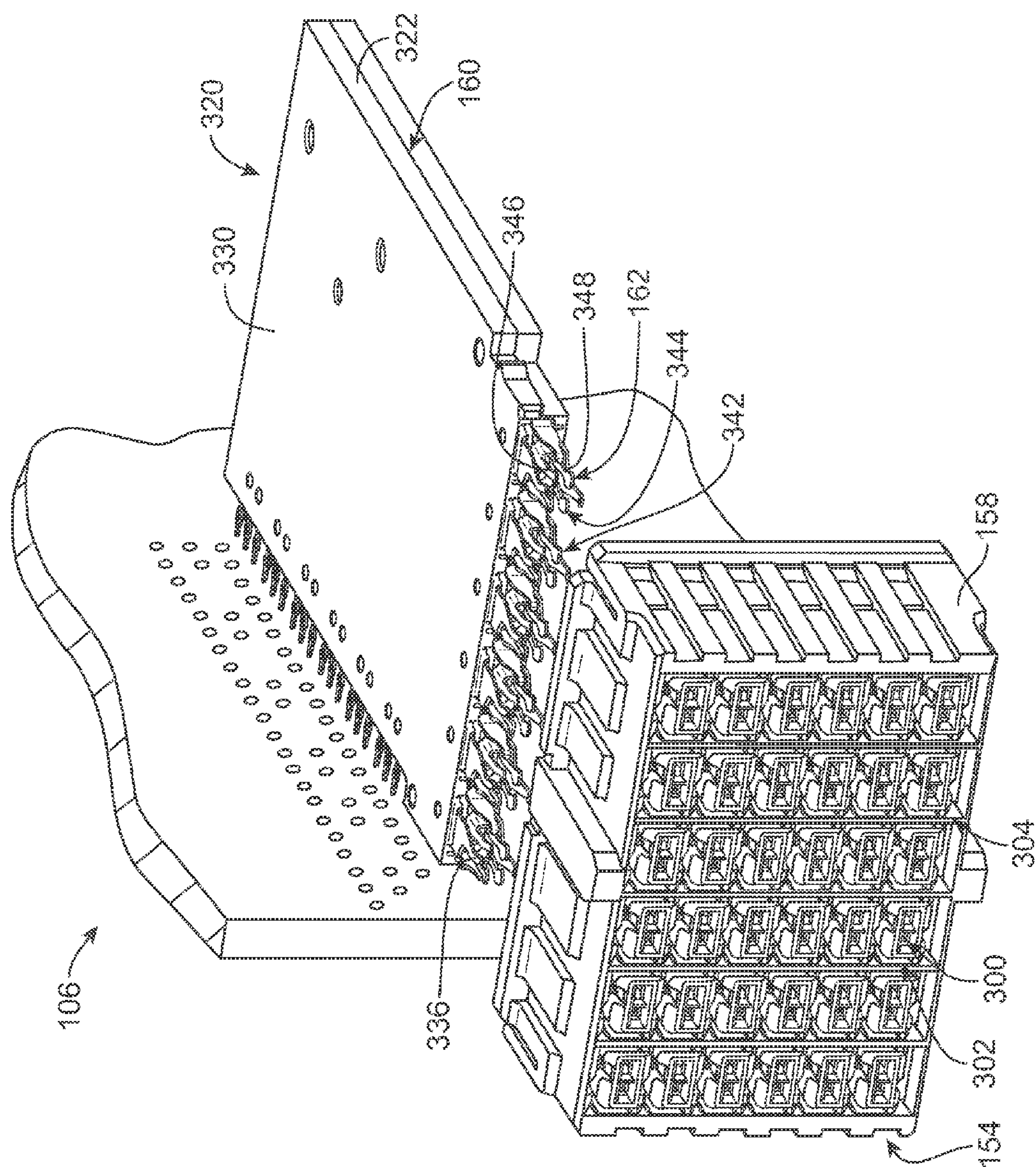
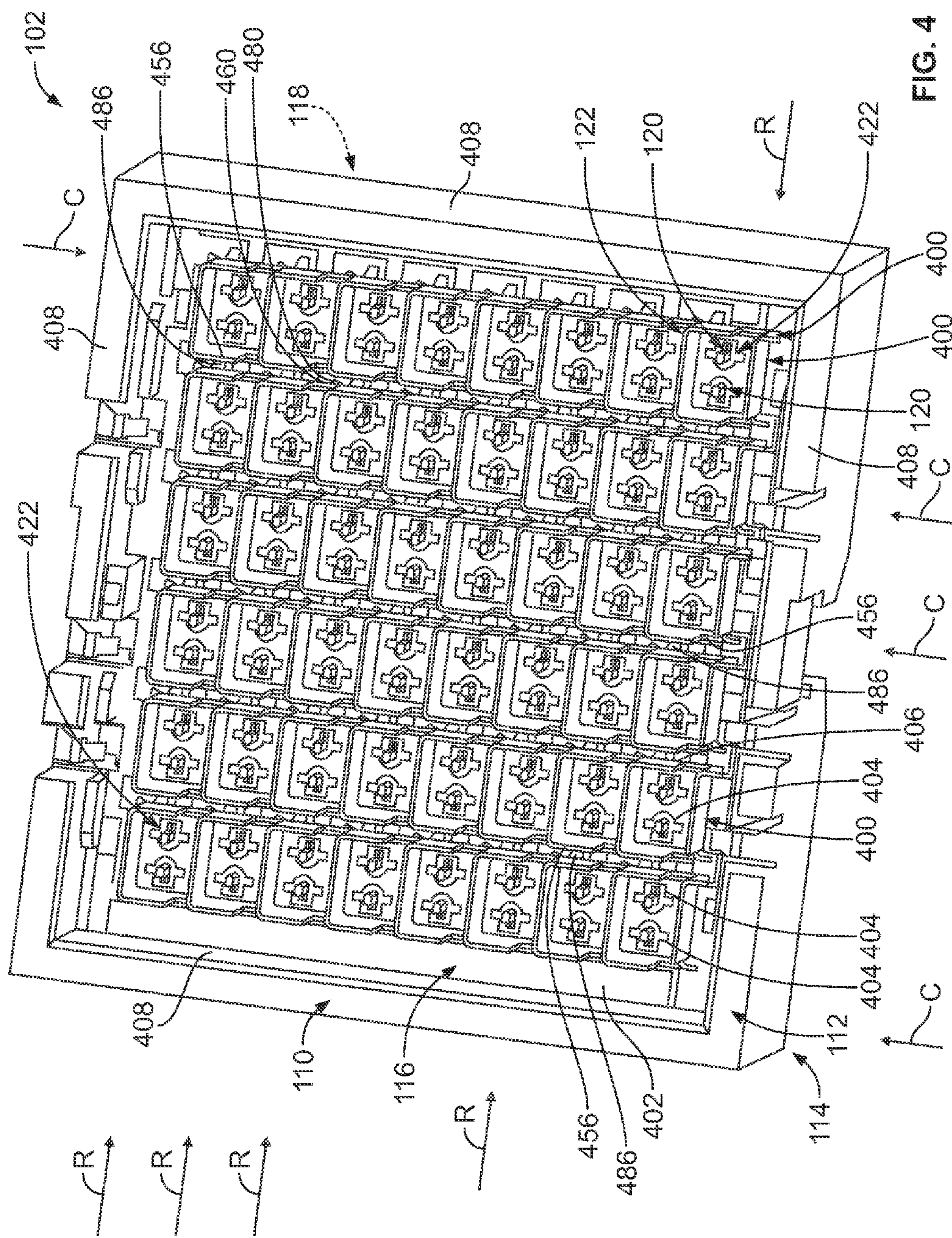



FIG. 2





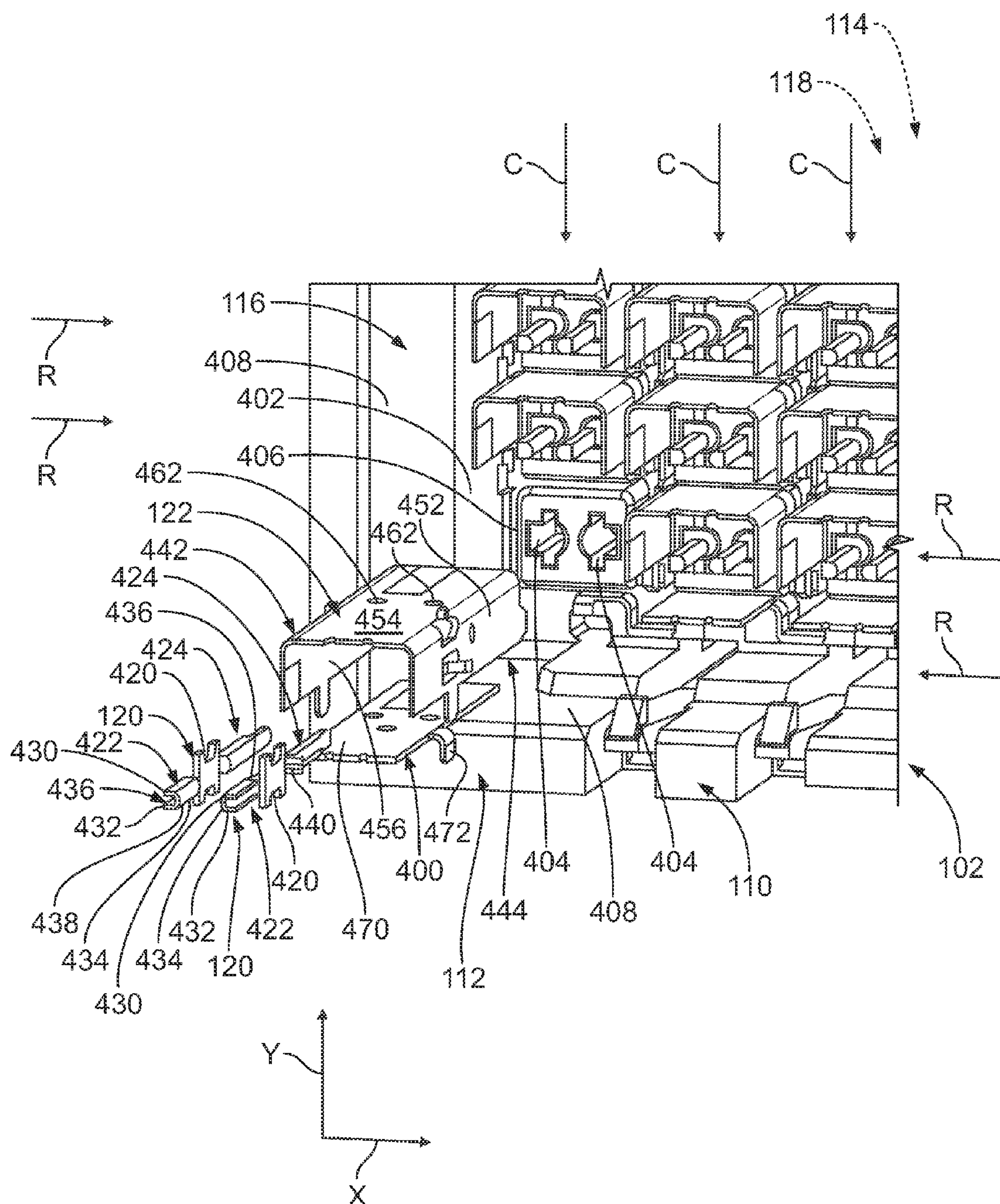


FIG. 5

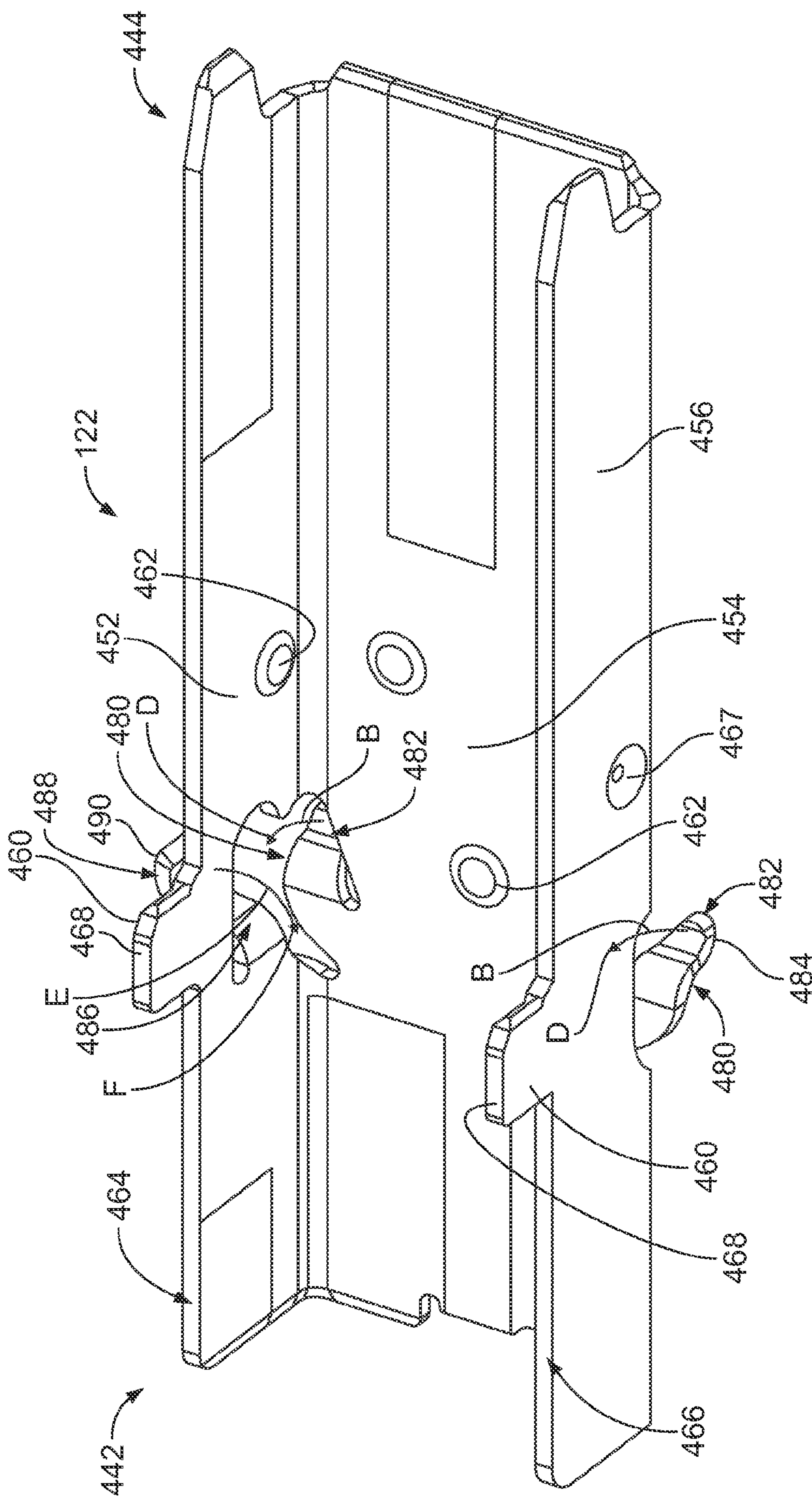


FIG. 6

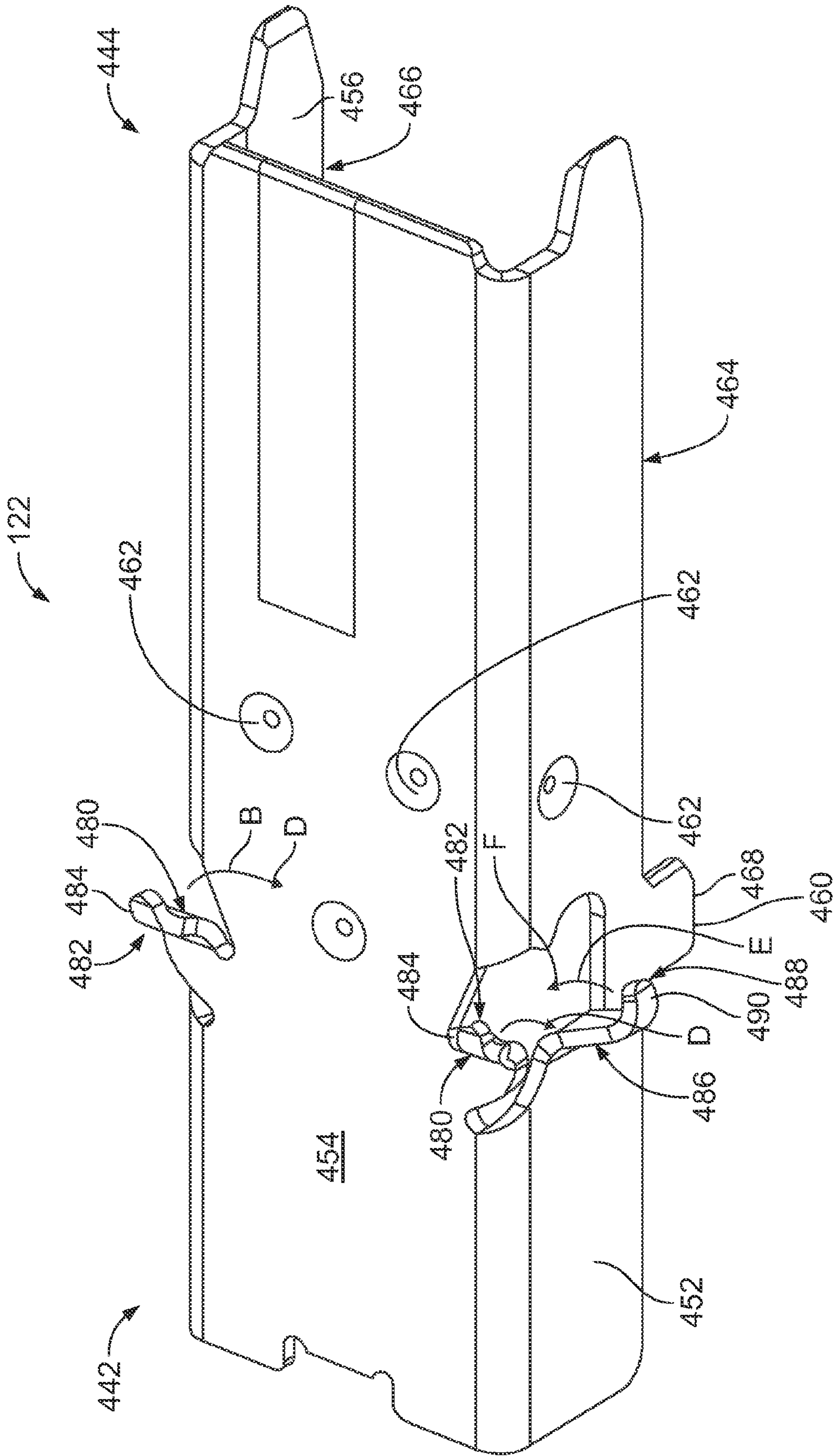
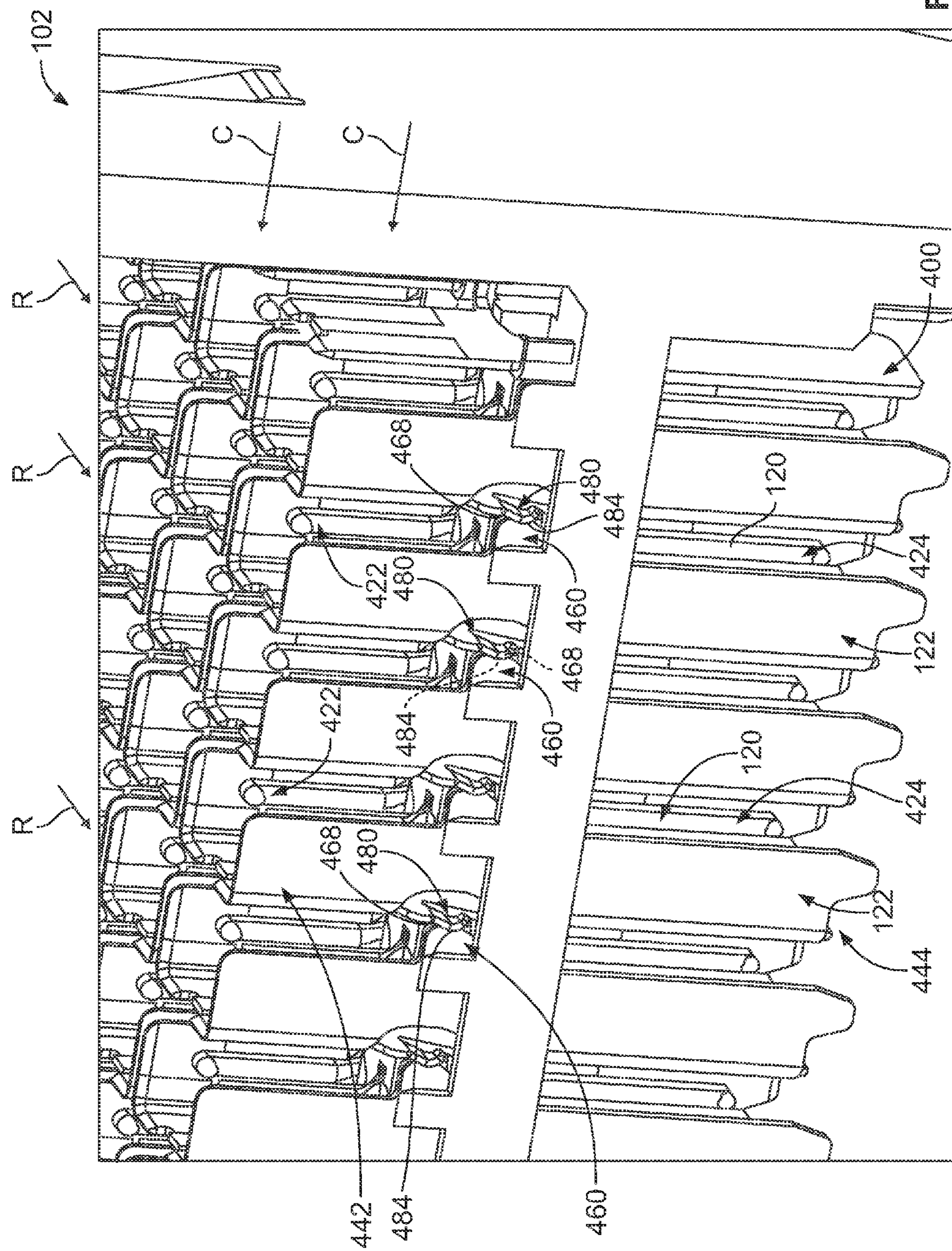


FIG. 7



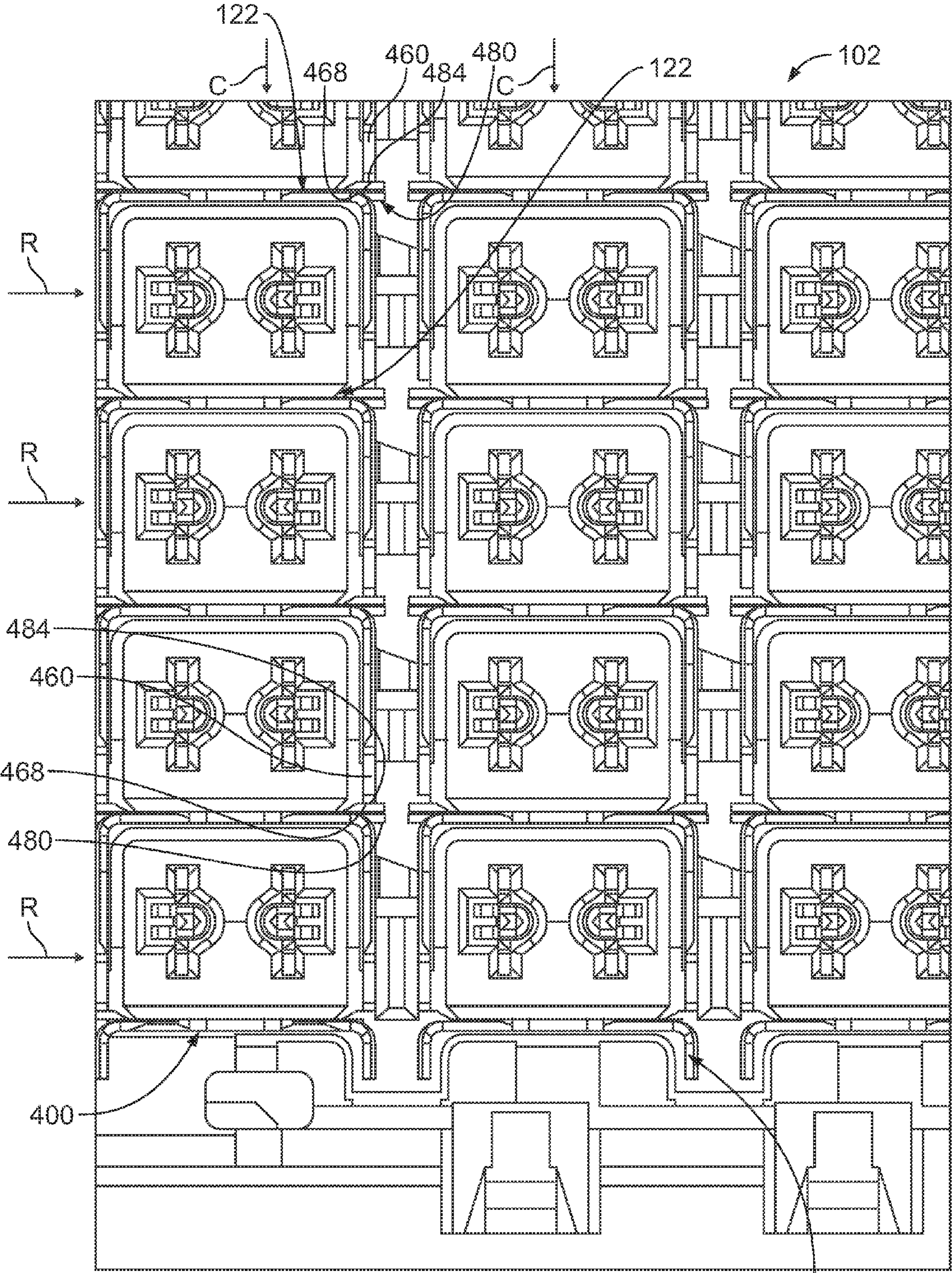


FIG. 9

400

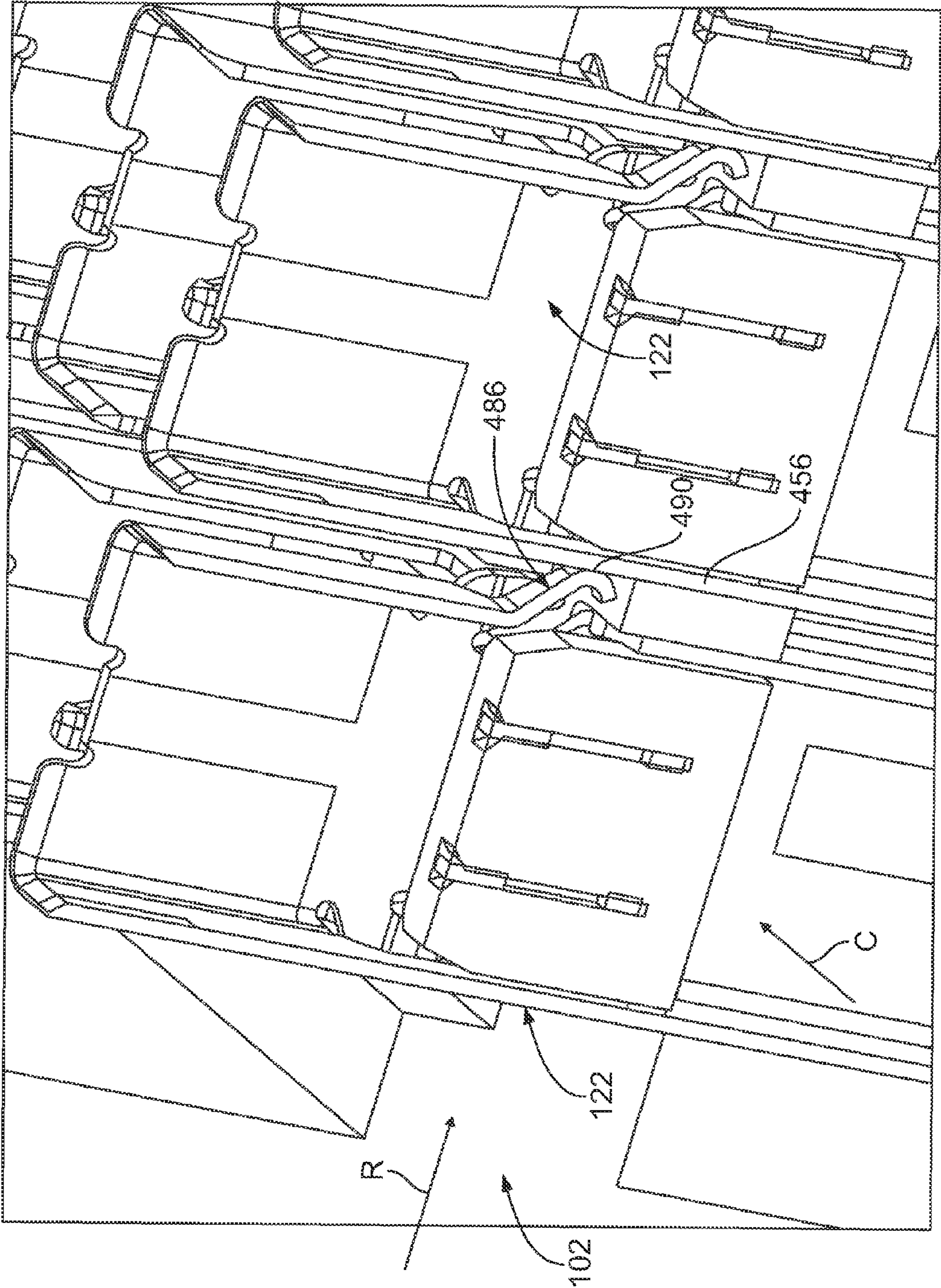


FIG. 10

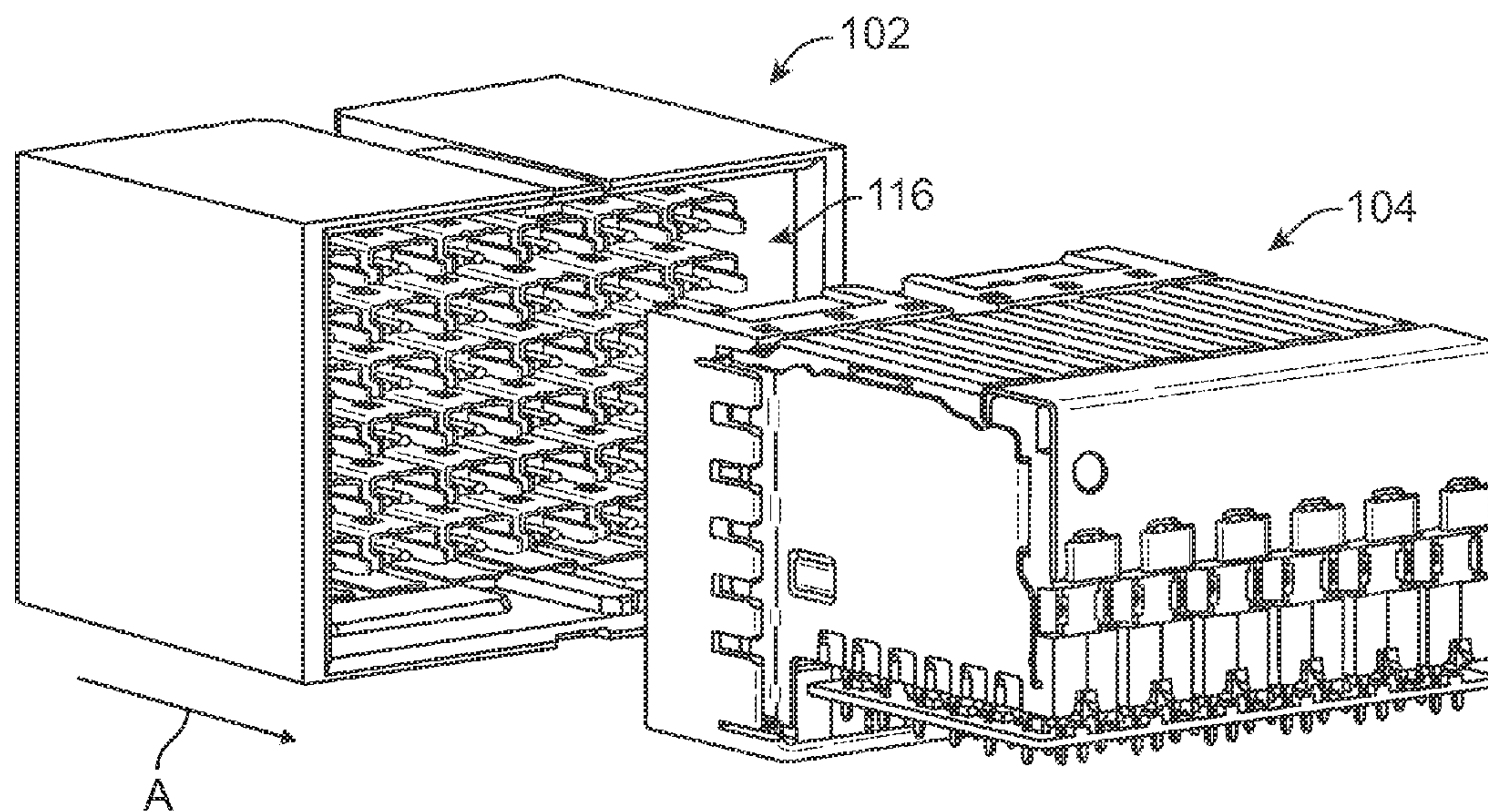


FIG. 11

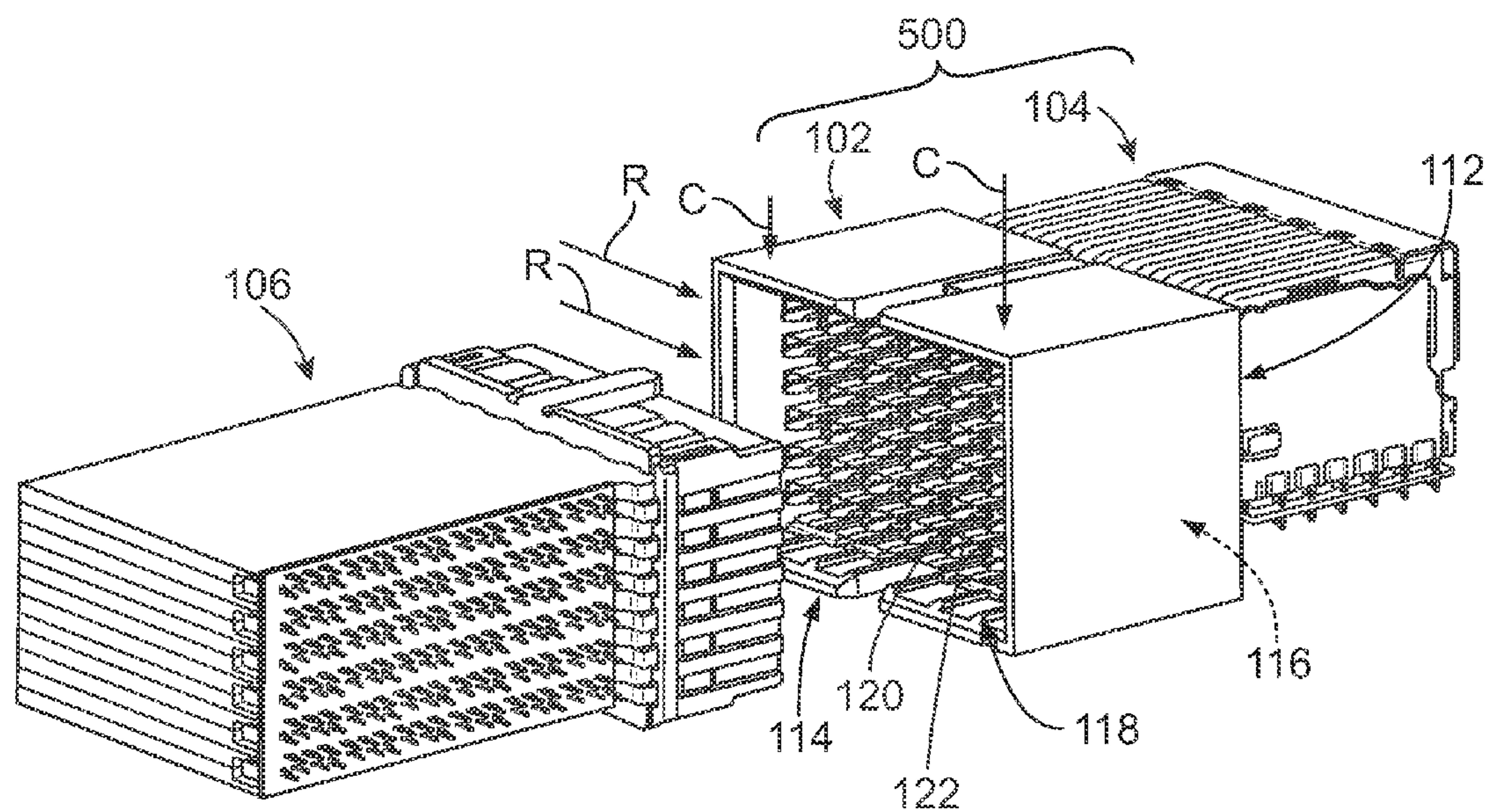


FIG. 12

1

**HEADER TRANSITION CONNECTOR FOR
AN ELECTRICAL CONNECTOR SYSTEM****BACKGROUND OF THE INVENTION**

The subject matter herein relates generally to a header transition connector for use in an electrical connector system.

Some electrical systems, such as network switches and computer servers with switching capability, include receptacle connectors that are oriented orthogonally on opposite sides of a midplane in a cross-connect application. Switch cards may be connected on one side of the midplane and line cards may be connected on the other side of the midplane. The line card and switch card are joined through header connectors that are mounted on opposite sides of the midplane board. Using the midplane circuit board and header connectors adds to the cost and overall size of the electrical systems. Some known electrical systems have eliminated the midplane and header connectors by designing two connectors that mate directly to one another. But, midplanes typically include circuitry that cancels noise generated when passing an array of signals between the receptacle connectors. For example, signal noise may be generated from the array of signals passing through electrical vias of the switch and line cards and/or from the array of signals passing through the signal contacts of the receptacle connectors. Such known electrical systems having two connectors that mate directly together therefore may suffer from unwanted signal noise because of the absence of the midplane.

A need remains for an improved electrical connector system for mating receptacle connectors without a midplane circuit board.

BRIEF DESCRIPTION OF THE INVENTION

In an embodiment, a header transition connector includes a header housing having a separating wall separating a first cavity from a second cavity. Header signal contacts are held by the header housing. The header signal contacts are arranged in pairs carrying differential signals. The header signal contacts have first mating ends in the first cavity for mating with a first receptacle connector. The header signal contacts have second mating ends in the second cavity for mating with a second receptacle connector. Header ground shields are held by the header housing. The header ground shields have walls surrounding associated pairs of header signal contacts on at least two sides thereof. The header ground shields have first mating ends in the first cavity for mating with the first receptacle connector. The header ground shields have second mating ends in the second cavity for mating with the second receptacle connector. At least a group of the header ground shields are electrically commoned with each other within the header housing.

In an embodiment, a header transition connector includes a header housing having a separating wall separating a first cavity from a second cavity. Header signal contacts are held by the header housing. The header signal contacts are arranged in pairs carrying differential signals. The header signal contacts have first mating ends in the first cavity for mating with a first receptacle connector. The header signal contacts have second mating ends in the second cavity for mating with a second receptacle connector. Header ground shields are held by the header housing. The header ground shields have walls surrounding associated pairs of header signal contacts on at least two sides thereof. The header ground shields have first mating ends in the first cavity for

2

mating with the first receptacle connector. The header ground shields have second mating ends in the second cavity for mating with the second receptacle connector. A first of the header ground shields is engaged in physical contact with a second of the header ground shields such that the first and second header ground shields are electrically connected together.

In an embodiment, an electrical connector system includes a receptacle connector having receptacle signal contacts arranged in pairs carrying differential signals. The receptacle connector includes a ground shield having ground contacts extending therefrom. A header transition connector is coupled to the receptacle connector. The header transition connector includes a header housing holding header signal contacts and header ground shields. The header housing have a separating wall separating a first cavity from a second cavity. The receptacle connector is configured to be received in the first cavity. The header signal contacts are arranged in pairs carrying differential signals. The header signal contacts have first mating ends that extend in the first cavity and are configured to be mated with the receptacle signal contacts of the receptacle connector. The header signal contacts have second mating ends that extend in the second cavity for mating with a second receptacle connector. The header ground shields have first mating ends in the first cavity for mating with the ground contacts of the receptacle connector. The header ground shields have second mating ends in the second cavity for mating with the second receptacle connector. A first of the header ground shields is engaged in physical contact with a second of the header ground shields such that the first and second header ground shields are electrically connected together.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of an embodiment of an electrical connector system.

FIG. 2 is a front, partially exploded perspective view of an embodiment of a first receptacle connector of the electrical connector system shown in FIG. 1.

FIG. 3 is a front perspective view of a portion of an embodiment of a second receptacle connector of the electrical connector system shown in FIG. 1.

FIG. 4 is a perspective view of an embodiment of a header transition connector of the electrical connector system shown in FIG. 1.

FIG. 5 is an enlarged partially exploded perspective view of the header transition connector shown in FIG. 4.

FIG. 6 is a perspective view of an embodiment of a header ground shield of the header transition connector shown in FIGS. 4 and 5.

FIG. 7 is another perspective view of the header ground shield shown in FIG. 6 viewed in a different orientation as compared to FIG. 6.

FIG. 8 is a perspective view of the header transition connector shown in FIGS. 4 and 5 illustrating a cross section of the header transition connector.

FIG. 9 is an elevational view of a portion of the header transition connector shown in FIGS. 4, 5, and 8.

FIG. 10 is a perspective view of the header transition connector shown in FIGS. 4, 5, 8, and 9 illustrating another cross section of the header transition connector.

FIG. 11 illustrates the header transition connector shown in FIGS. 4, 5, and 8-10 poised for mating with the first receptacle connector shown in FIG. 2.

FIG. 12 is a front perspective view of the header transition connector shown in FIGS. 4, 5, and 8-10 coupled to the first receptacle connector shown in FIG. 2 to form a header assembly.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 is a perspective view of an embodiment of an electrical connector system 100. The electrical connector system 100 includes a header transition connector 102, a first receptacle connector 104 configured to be coupled to one side of the header transition connector 102, and a second receptacle connector 106 configured to be connected to another side the header transition connector 102. The header transition connector 102 is used to electrically connect the first and second receptacle connectors 104 and 106 together. Optionally, the first receptacle connector 104 is part of a daughter card and the second receptacle connector 106 is, or forms a portion of, a backplane, or vice versa. The first and second receptacle connectors 104 and/or 106 may be, and/or may form a portion of, a line card and/or a switch card.

The header transition connector 102 makes direct electrical connections to both receptacle connectors 104 and 106 without the need for a midplane circuit board (not shown). The header transition connector 102 is a single connector that is able to electrically interconnect the two receptacle connectors 104 and 106. Each of the receptacle connectors 104 and 106 may be any type of receptacle connector, such as, but not limited to, STRADA Whisper receptacle connectors commercially available from TE Connectivity, Harrisburg PA. The header transition connector 102 allows convenient electrical connection between the receptacle connectors 104 and 106, with few parts and without the need for a midplane circuit board.

As will be described below, the header transition connector 102 includes header ground shields 122. At least some (e.g., a group as will be described below) of the header ground shields 122 are electrically commoned with each other within a header housing 110 (described below) of the header transition connector 102. Electrically commoning at least some of the header ground shields 122 within the header housing 110 may provide an electrical connector system 100 that mates the receptacle connectors 104 and 106 together without a midplane circuit board but that behaves electrically as if a midplane circuit board is present.

In an exemplary embodiment, the header transition connector 102 may be coupled to one of the receptacle connectors (e.g., the first receptacle connector 104) to change the mating interface presented to the other receptacle connector (e.g., the second receptacle connector 106). For example, the first receptacle connector 104 may have contacts each having a receptacle type mating end, such as, but not limited to, a split beam type of contact that defines a receptacle. The second receptacle connector 106 may have similar or identical contacts as the first receptacle connector 104, such as, but not limited to, split beam type of contacts that define receptacles. The receptacle connectors 104 and 106 have mating interfaces that do not allow direct mating therebetween; however, the header transition connector 102 is able to mate directly with the first receptacle connector 104 and is able to mate directly with the second receptacle connector 106. The header transition connector 102 is an adaptor that facilitates electrical interconnection of the receptacle connectors 104 and 106. For example, the header transition connector 102 may include pin-type contacts at both mating interfaces of the header transition connector 102 that are

able to be mated with the receptacle type contacts of both of the receptacle connectors 104 and 106. In such an example, mounting the header transition connector 102 to the first receptacle connector 104 changes the mating interface presented to the second receptacle connector 106 from a receptacle contact type of interface to a pin contact type of interface. The header transition connector 102 thus defines an adapter that changes the mating interface of the receptacle connector 104 for mating with another connector, for example the receptacle connector 106, that could not mate directly with the receptacle connector 104.

The header transition connector 102 includes the header housing 110 having a first end 112 and a second end 114. The header housing 110 defines a first cavity 116 (visible in FIGS. 4 and 5) at the first end 112 and a second cavity 118 at the second end 114. In an exemplary embodiment, the first cavity 116 receives the first receptacle connector 104 and the second cavity 118 receives the second receptacle connector 106. The header transition connector 102 includes header signal contacts 120 held by the header housing 110 and header ground shields 122 held by the header housing 110. The header signal contacts 120 are arranged in both the cavities 116 and 118 for mating with the first and second receptacle connectors 104 and 106. Optionally, the header signal contacts 120 may be arranged in pairs carrying differential signals. The header ground shields 122 are arranged in both the cavities 116 and 118 for mating with both of the receptacle connectors 104 and 106. The header ground shields 122 provide electrical shielding for the header signal contacts 120.

In the illustrated embodiment, the header signal contacts 120 have an identical pinout in both the cavities 116 and 118 allowing the first receptacle connector 104 to be loaded into either the first cavity 116 or the second cavity 118. Similarly, the second receptacle connector 106 may be loaded into either the first cavity 116 or the second cavity 118. Optionally, identical receptacle connectors may be loaded into both cavities 116 and 118 for electrical connection by the header transition connector 102. For example, two receptacle connectors that are identical to the first receptacle connector 104 (which may be referred to as “pair-in-row” receptacle connectors) may be plugged into the cavities 116 and 118. Alternatively, two receptacle connectors that are identical to the second receptacle connector 106 (which may be referred to as “pair-in-column” receptacle connectors) may be plugged into the cavities 116 and 118. The header transition connector 102 can accommodate either type of receptacle connector 104 or 106 in either cavity 116 or 118.

Each of the header ground shields 122 peripherally surrounds an associated pair of the header signal contacts 120 in the illustrated embodiment. Moreover, the illustrated embodiment of the header ground shields 122 are C-shaped, covering three sides of the associated pair of header signal contacts 120. One side of the header ground shield 122 is open. In the illustrated embodiment, each of the header ground shields 122 has an open bottom, and an adjacent header ground shield 122 below the open bottom provides shielding across the open bottom. Each pair of header signal contacts 120 is therefore surrounded on all four sides thereof by the associated C-shaped header ground shield 122 and the adjacent header ground shield 122 below the pair of header signal contacts 120. As such, the header ground shields 122 cooperate to provide circumferential electrical shielding for each pair of header signal contacts 120. The header ground shields 122 electrically shield each pair of header signal contacts 120 from every other pair of header signal contacts 120. For example, the header ground shields 122 may span

5

all direct line paths from any one pair of the header signal contacts **120** to any other pair of the header signal contacts **120** to provide electrical shielding across all of the direct line paths. In the illustrated embodiment, the header ground shield **122** spans entirely across the top of both header signal contacts within the associated pair. The header ground shield **122** may provide better electrical shielding than individual header ground contacts of at least some known header assemblies.

In some other embodiment, other types of header ground shields **122** may be provided. For example, L-shaped header ground shields **122** may be used that provide shielding on two sides of the associated pair of header signal contacts **120**, wherein cooperation with other header ground shields **122** provides electrical shielding on all sides (e.g. above, below, and on both sides of the pair). In some other embodiments, and for example, the header ground shields **122** may be associated with individual header signal contacts **120** as opposed to pairs of header signal contacts **120**.

The first receptacle connector **104** is mounted to a first circuit board **130** at a mounting surface **132** of the first circuit board **130**. The first receptacle connector **104** has a header interface **134** configured to be mated with the header transition connector **102**. The first receptacle connector **104** has a board interface **136** configured to be mounted to the mounting surface **132** of the first circuit board **130**. In the illustrated embodiment, the board interface **136** is orientated perpendicular to the header interface **134**. When the first receptacle connector **104** is coupled to the header transition connector **102**, the first circuit board **130** is orientated horizontally with the first receptacle connector **104** above the first circuit board **130**; however, other orientations are possible in other embodiments.

The first receptacle connector **104** includes a first receptacle housing **138** used to hold a plurality of first contact modules **140**. The contact modules **140** are held in a stacked configuration generally parallel to one another. In the illustrated embodiment, the contact modules **140** are oriented generally along vertical planes. The contact modules **140** hold a plurality of first receptacle signal contacts **142** (shown in FIG. 2) that are electrically connected to the first circuit board **130** and define signal paths through the first receptacle connector **104**. The receptacle signal contacts **142** are configured to be electrically connected to the header signal contacts **120**. The contact modules **140** optionally provide electrical shielding for the receptacle signal contacts **142**. Optionally, the receptacle signal contacts **142** may be arranged in pairs carrying differential signals. The contact modules **140** may generally provide 360° shielding for each pair of receptacle signal contacts **142** along substantially the entire length of the receptacle signal contacts **142** between the board interface **136** and the header interface **134**. The shield structure of the contact modules **140** that provides the electrical shielding for the pairs of receptacle signal contacts **142** is electrically connected to the header ground shields **122** and is electrically connected to a ground plane of the first circuit board **130**.

In the illustrated embodiment, mating ends of the receptacle signal contacts **142** are arranged in an array in rows and columns (contained within the receptacle housing **138** and thus not shown in FIG. 1; however the pattern is evident from the arrangement of the openings in the receptacle housing **138**). The receptacle signal contacts **142** within each contact module **140** define a column of signal contacts. The rows are defined as being oriented parallel to the mounting surface **132** of the first circuit board **130**. In the illustrated embodiment, the columns are oriented vertically and the

6

rows are oriented horizontally. The receptacle signal contacts **142** within each pair are arranged in a same row, and thus the first receptacle connector **104** defines a pair-in-row receptacle connector. The receptacle signal contacts **142** within each contact module **140** are in a same column. Optionally, the contact modules **140** are manufactured using overmolded leadframes and the receptacle signal contacts **142** from a same leadframe are within a same column. The receptacle signal contacts **142** within each pair optionally are arranged in a same contact module **140**.

The second receptacle connector **106** is mounted to a second circuit board **150** at a mounting surface **152** of the second circuit board **150**. The second receptacle connector **106** is configured to be coupled to the header transition connector **102**. The second receptacle connector **106** has a header interface **154** configured to be mated with the header transition connector **102**. The second receptacle connector **106** has a board interface **156** configured to be mounted to the mounting surface **152** of the second circuit board **150**. In the illustrated embodiment, the board interface **156** is orientated perpendicular to the header interface **154**. When the second receptacle connector **106** is coupled to the header transition connector **102**, the second circuit board **150** is orientated vertically with the second receptacle connector **106** along one side of the second circuit board **150**; however, other orientations are possible in other embodiments. Optionally, the second circuit board **150** is oriented perpendicular to the first circuit board **130**, as is shown in the illustrated embodiment.

The second receptacle connector **106** includes a second receptacle housing **158** used to hold a plurality of second contact modules **160**. The contact modules **160** are held in a stacked configuration generally parallel to one another. In the illustrated embodiment, the contact modules **160** are oriented generally along horizontal planes. The contact modules **160** hold a plurality of receptacle signal contacts **162** (shown in FIG. 3) that are electrically connected to the second circuit board **150** and define signal paths through the second receptacle connector **106**. The receptacle signal contacts **162** are configured to be electrically connected to the header signal contacts **120**. In an exemplary embodiment, the contact modules **160** provide electrical shielding for the receptacle signal contacts **162**. Optionally, the receptacle signal contacts **162** may be arranged in pairs carrying differential signals. The contact modules **160** may generally provide 360° shielding for each pair of receptacle signal contacts **162** along substantially the entire length of the receptacle signal contacts **162** between the board interface **156** and the header interface **154**. The shield structure of the contact modules **160** that provides electrical shielding for the pairs of receptacle signal contacts **162** is electrically connected to the header ground shields **122** of the header transition connector **102** and is electrically connected to a ground plane of the second circuit board **150**.

In the illustrated embodiment, mating ends of the receptacle signal contacts **162** are arranged in an array in rows and columns (contained within the receptacle housing **158** and thus not shown in FIG. 1; however, the pattern is evident from the arrangement of the openings in the receptacle housing **158**). The receptacle signal contacts **162** within each contact module **160** define a column of signal contacts. The rows are defined as being oriented parallel to the mounting surface **152** of the second circuit board **150**. In the illustrated embodiment, the columns are oriented horizontally and the rows are oriented vertically. The receptacle signal contacts **162** within each pair are arranged in a same column, and thus the second receptacle connector **106** defines a pair-in-col-

7

umn receptacle connector. The receptacle signal contacts **162** within each contact module **160** are in a same column. Optionally, the contact modules **160** are manufactured using overmolded leadframes and the receptacle signal contacts **162** from a same leadframe are within a same column. 5 Optionally, the receptacle signal contacts **162** within each pair are arranged in a same contact module **160**.

FIG. **2** is a front, partially exploded perspective view of an embodiment of the first receptacle connector **104**. The first receptacle housing **138** is manufactured from a dielectric material, such as, but not limited to, a plastic material. The first receptacle housing **138** includes a plurality of signal contact openings **200** and a plurality of ground contacts openings **202** that are through passages extending from the mating end **204** through the first receptacle housing **138**. The mating end **204** defines a portion of the header interface **134** of the first receptacle connector **104**. 10

The contact modules **140** are coupled to the first receptacle housing **138** such that the receptacle signal contacts **142** are received in corresponding signal contact openings **200**. Optionally, a single receptacle signal contact **142** is received in each signal contact opening **200**. The signal contact openings **200** may also receive corresponding header signal contacts **120** (shown in FIGS. **1**, **4**, **5**, **8**, and **12**) therein when the receptacle connector **104** is coupled to the header transition connector **102** (shown in FIGS. **1**, **2**, **11**, and **12**). 20

The ground contact openings **202** receive corresponding header ground shields **122** (shown in FIGS. **1**, **4-10**, and **12**) therein when the receptacle connector **104** is coupled to the header transition connector **102**. The ground contact openings **202** receive grounding members (e.g., grounding contacts **236** of the contact modules **140**), which mate with the header ground shields **122** to electrically common the grounding contacts **236** and the header ground shields **122**. The ground contact openings **202** are C-shaped in the illustrated embodiment to receive the C-shaped header ground shields **122**. Other shapes are possible in other embodiments, for example when other shaped header ground shields **122** are used. 30

The contact modules **140** each include a holder **210** that holds a frame assembly **220**. Optionally, the holder **210** may be an electrically conductive holder to provide electrical shielding, for example a holder manufactured from a metal material and/or a metalized plastic material. The frame assembly **220** includes a dielectric frame **230** surrounding a leadframe **232**. Optionally, the leadframe **232** is stamped and formed to define the receptacle signal contacts **142**. Other manufacturing processes may be utilized to form the contact modules **140**. 40

The conductive holder **210** provides electrical shielding for the receptacle signal contacts **142**. The conductive holder **210** may include portions that are positioned between some or all of the receptacle signal contacts **142** to provide electrical shielding. Optionally, a shield **234** may be coupled to the holder **210**. The shield **234** includes the grounding contacts **236** and grounding pins **238**, which may be electrically terminated to the circuit board **130**. 50

Although not shown in FIG. **2**, it should be apparent from the exploded portion of FIG. **2** that the receptacle signal contacts **142** have mating portions **242** that extend from the front wall of the dielectric frame **230**. The mating portions **242** are configured to be mated with, and electrically connected to, corresponding header signal contacts **120** (shown in FIGS. **1**, **4**, **5**, **8**, and **12**). The mating portions **242** within each contact module **140** are arranged in a column. The mating portions **242** define receptacle type mating ends 60

8

having a receptacle **244** that is configured to receive a pin type contact, such as the header signal contact **120**. In the illustrated embodiment, each mating portion **242** is a split beam type of contact having opposed beams **246** and **248** defining and flanking the receptacle **244**. Other types of mating portions may be provided in other embodiments.

The mating portions **242**, the grounding contacts **236**, and the first receptacle housing **138** together define the header interface **134**. For example, the size and shape of the perimeter of the first receptacle housing **138** as well as the shapes and positions of the mating portions **242** and the grounding contacts **236** define the header interface **134**. For example, the mating portions **242** have a predetermined pinout defined by the relative positions of the mating portions **242**. The header interface **134** is configured for mating with the header transition connector **102** (shown in FIGS. **1**, **4**, **5**, and **8-12**). 10

The receptacle signal contacts **142** are optionally arranged as differential pairs. The pair of receptacle signal contacts **142** is arranged in a row, which defines the receptacle connector **104** as a pair-in-row receptacle connector **104**. The conductive holders **210** may be designed to provide electrical shielding between and around respective pairs of the receptacle signal contacts **142**. The conductive holders **210** may provide 360° shielding around each pair of receptacle signal contacts **142**. The conductive holders **210** provide shielding from electromagnetic interference (EMI) and/or radio frequency interference (RFI). 20

FIG. **3** is a front perspective view of a portion of an embodiment of the second receptacle connector **106**. FIG. **3** illustrates one of the contact modules **160** poised for loading into the second receptacle housing **158**. The second receptacle housing **158** is manufactured from a dielectric material, such as, but not limited to, a plastic material. The second receptacle housing **158** includes a plurality of signal contact openings **300** and a plurality of ground contacts openings **302** that are through passages that extend from a mating end **304** through the second receptacle housing **158**. The mating end **304** defines a portion of the header interface **154** of the second receptacle connector **106**. 30

The contact module **160** is coupled to the second receptacle housing **158** such that the receptacle signal contacts **162** are received in corresponding signal contact openings **300**. Optionally, a single receptacle signal contact **162** is received in each signal contact opening **300**. The signal contact openings **300** may also receive corresponding header signal contacts **120** (shown in FIGS. **1**, **4**, **5**, **8**, and **12**) therein when the receptacle connector **106** is mated with the header transition connector **102** (shown in FIGS. **1**, **4**, **5**, and **8-12**). 40

The ground contact openings **302** receive corresponding header ground shields **122** (shown in FIGS. **1**, **4-10**, and **12**) therein when the receptacle connector **106** is mated with the header transition connector **102**. The ground contact openings **302** receive grounding members, for example grounding contacts **336** of the contact modules **160**, which mate with the header ground shields **122**. The ground contact openings **302** are C-shaped in the illustrated embodiment to receive the C-shaped header ground shields **122**. Other shapes are possible in other embodiments, such as, but not limited to, when other shaped header ground shields **122** are used. 50

The contact module **160** includes a frame assembly **320**, which includes the receptacle signal contacts **162**. The receptacle signal contacts **162** are arranged in pairs carrying differential signals. Optionally, the frame assembly **320** includes a dielectric frame **322** that surrounds the receptacle 65

signal contacts. The dielectric frame 322 optionally is over-molded over a leadframe, which is optionally stamped and formed to define the receptacle signal contacts 162.

The contact module 160 may include a shield 330 that provides shielding for the receptacle signal contacts 162. In the illustrated embodiment, portions of the shield 330 are positioned between pairs of the receptacle signal contacts 162 to provide shielding between adjacent pairs of the receptacle signal contacts 162. The shield 330 provides electrical shielding between and around respective pairs of the receptacle signal contacts 162. The shield 330 includes the grounding contacts 336 that provide shielding for mating portions 342 of the receptacle signal contacts 162. Optionally, the shield 330 may be a multi-piece shield. For example, the grounding contacts 336 may be separately stamped and formed from grounding bars that are mechanically and electrically connected to the base structure of the shield 330. The grounding contacts 336 may extend along three sides of the pair of receptacle signal contacts 162.

The mating portions 342 extend from the front wall of the dielectric frame 322. The mating portions 342 are configured to be mated with and electrically connected to corresponding header signal contacts 120 (shown in FIGS. 1, 4, 5, 8, and 12). The mating portions 342 within each contact module 160 are arranged in a column. The mating portions 342 define receptacle type mating ends having a receptacle 344 that is configured to receive a pin type contact, for example the header signal contact 120. In the illustrated embodiment, each mating portion 342 is a split beam type of contact having opposed beams 346, 348 defining and flanking the receptacle 344. Other types of mating portions may be provided in other embodiments.

The mating portions 342, the grounding contacts 336, and the second receptacle housing 158 together define the header interface 154. For example, the size and shape of the perimeter of the second receptacle housing 158 as well as the shapes and positions of the mating portions 342 and the grounding contacts 336 define the header interface 154. For example, the mating portions 342 have a predetermined pinout defined by the relative positions of the mating portions 342. Optionally, the pinout may be identical to the pinout defined by the first receptacle connector 104 (shown in FIGS. 1, 2, 11, and 12) such that the receptacle connectors 104 and 106 are interchangeable and configured to be mated to either end 112 or 114 (both shown in FIGS. 1, 4, 5, and 12) of the header transition connector 102.

Optionally, the receptacle signal contacts 162 are arranged as differential pairs. Both receptacle signal contacts 162 of each pair optionally are part of the same contact module 160. The pair of receptacle signal contacts 162 is arranged in the column defined by the contact module 160 and as such the receptacle connector 106 is a pair-in-column receptacle connector 106.

FIG. 4 is a perspective view of an embodiment of the header transition connector 102. FIG. 5 is an enlarged partially-exploded perspective view of the header transition connector 102 showing an orphan ground shield 400, a pair of the header signal contacts 120 and one of the header ground shields 122 poised for loading into the header housing 110.

Referring now to FIGS. 4 and 5, the header housing 110 of the header transition connector 102 is manufactured from a dielectric material, for example a plastic material. The header housing 110 includes a separating wall 402 between the first cavity 116 and the second cavity 118 (visible in FIG. 1). The separating wall 402 includes signal contact openings

404 that receive corresponding header signal contacts 120 and ground shield openings 406 that receive corresponding header ground shields 122. The signal contact openings 404 are sized and shaped to hold the header signal contacts 120 therein. The ground shield openings 406 are sized and shaped to hold the header ground shields 122 therein.

The header housing 110 includes shroud walls 408 extending from the separating wall 402 to the first end 112 and the second end 114. The shroud walls 408 define the cavities 116 and 118. The shroud walls 408 surround exposed portions of the header signal contacts 120 and the header ground shields 122. The receptacle connectors 104 (shown in FIGS. 1, 2, 11, and 12) and 106 (shown in FIGS. 1, 3, 11, and 12) are configured to be coupled to the shroud walls 408. During mating, the shroud walls 408 may guide the receptacle connectors 104 and 106 into the cavities 116 and 118, respectively, or vice versa.

Referring now solely to FIG. 5, the orphan ground shield 400 is positioned in the corresponding ground shield opening 406 below the bottom-most pair of header signal contacts 120. The orphan ground shield 400 provides shielding below the bottom-most pair of header signal contacts 120. In the illustrated embodiment, the orphan ground shield 400 includes a single planar wall 470; however, the orphan ground shield 400 may include multiple walls in other embodiments.

The orphan ground shield 400 includes one or more optional tabs 472 extending from the wall 470. The tabs 472 are used to stop or locate the orphan ground shield 400 in the corresponding ground shield opening 406, for example to limit the amount that the orphan ground shield 400 is loaded into the corresponding ground shield opening 406. The tabs 472 may define push surfaces for pushing or loading the orphan ground shield 400 into the corresponding ground shield opening 406. Optionally, the first receptacle connector 104 (shown in FIGS. 1, 2, 11, and 12) or the second receptacle connector 106 (shown in FIGS. 1, 3, 11, and 12) may be positioned immediately behind the tabs 472 within the cavity 116 or within the cavity 118 to block the orphan ground shield 400 from being pushed out of the corresponding ground shield opening 406, for example when the other receptacle connector 104 or 106 is loaded into the other cavity 116 or 118.

Although the wall 470 is shown as an integrally formed single, unitary structure, alternatively the wall 470 is formed from two or more separately (i.e., discretely) formed structures.

Optionally, the header signal contacts 120 are substantially similar to each other. Each header signal contact 120 includes a base section 420, which may be approximately centered along a length of the header signal contact 120. Optionally, the header signal contact 120 is a stamped and formed contact. The base section 420 is configured to be received in the corresponding signal contact opening 404 and held therein, such as by an interference fit.

The header signal contact 120 includes a first mating end 422 extending from one side of the base section 420 and a second mating end 424 extending from the opposite side of the base section 420. The first mating end 422 is configured to extend into the first cavity 116 for mating with a respective signal contact 142 (FIG. 2) of the first receptacle connector 104. The second mating end 424 is configured to extend into the second cavity 118 for mating with a respective signal contact 162 (FIG. 3) of the second receptacle connector 106. In the illustrated embodiment, each of the

11

mating ends **422** and **424** defines a pin type contact having a generally equal width and height (defined in the X and Y directions, respectively).

In the illustrated embodiment, each of the mating ends **422** and **424** is formed into a U-shaped pin. For example, with reference to the first mating end **422** (the second mating end **424** may be formed in a similar manner), the pin is formed by bending or rolling an upper shoulder **430** and a lower shoulder **432** with a connecting segment **434** therebetween. The connecting segment **434** may be curved. In the illustrated embodiment, the upper and lower shoulders **430** and **432**, respectively, are generally planar and parallel to one another with a gap **436** therebetween. In other embodiments, the shoulders **430** and **432** may be curved and distal ends of the upper and lower shoulder may abut one another, for example to form a round or O-shaped pin rather than the U-shaped pin shown in the illustrated embodiment. Optionally, a tip **438** is formed at the distal end of the first mating end **422**. The tip **438** reduces stubbing with the receptacle signal contact **142** during mating.

The upper and lower shoulders **430** and **432**, respectively, may be compressible toward one another. For example, the shoulders **430** and **432** may be resiliently deflected by the beams **246** and **248** (shown in FIG. 2) of the corresponding receptacle signal contact **142** (shown in FIG. 2) when received in the receptacle **244** (shown in FIG. 2) thereof. The upper shoulder **430** defines an upward facing mating interface for mating with the upper beam **246** of the receptacle signal contact **142**. The lower shoulder **432** defines a downward facing mating interface for mating with the lower beam **248** of the receptacle signal contact **142**. The upper shoulder **430** and the lower shoulder **432** are both perpendicular to the base section **420**.

In the illustrated embodiment, the upper shoulder **430** and the lower shoulder **432** are parallel to corresponding upper and lower shoulders **430** and **432**, respectively, of the second mating end **424**. Optionally, the upper shoulder **430** and the lower shoulder **432** are coplanar with the upper and lower shoulders **430** and **432**, respectively, of the second mating end **424**. Optionally, the shoulders **430** and **432** of the second mating end **424** include ramps **440** extending therefrom that are used to control impedance, for example when the second receptacle connector **106** is not fully mated.

In the illustrated embodiment of the header signal contacts **120**, the various structures of each of the header signal contacts **120** are integrally formed as a single, unitary structure. Alternatively, one or more of the various structures of a header signal contact **120** (e.g., the first mating end **422**, the second mating end **424**, and/or the base section **420**) is separately (i.e., discretely) formed as a separate (i.e., discrete) structure from one or more other structures of the header signal contact **120**.

FIG. 6 is a perspective view of an embodiment of one of the header ground shields **122**. FIG. 7 is another perspective view of the header ground shield **122** viewed in a different orientation as compared to FIG. 6. Optionally, the header ground shields **122** are substantially similar.

Referring now to FIGS. 5-7, the header ground shields **122** are sized and shaped to provide electrical shielding around the pair of header signal contacts **120** (not shown in FIGS. 6 and 7). The header ground shields **122** each include a first mating end **442** and an opposite second mating end **444**. The first mating end **442** is configured to extend into the first cavity **116** (not shown in FIGS. 6 and 7) for mating with the grounding contacts **236** (shown in FIG. 2) of the first receptacle connector **104** (shown in FIGS. 1, 2, 11, and 12), while the second mating end **444** is configured to extend into

12

the second cavity **118** (shown in FIGS. 1, 4, 5, and 12) for mating with the grounding contacts **336** (shown in FIG. 3) of the second receptacle connector **106** (shown in FIGS. 1, 3, 11, and 12), or vice versa.

In the illustrated embodiment, the header ground shields **122** are C-shaped and provide shielding on three sides of the pair of header signal contacts **120**. The header ground shields **122** have a plurality of walls in the illustrated embodiment, namely three planar walls **452**, **454**, **456**. The walls **452**, **454**, **456** may be integrally formed as a single, unitary structure, or alternatively, one or more of the walls **452**, **454**, and/or **456** may be a separately (i.e., discretely) formed structure. The wall **454** defines a base wall or top wall of the header ground shield **122**. The walls **452** and **456** define side walls that extend from the base wall **454**. The side walls **452** and/or **456** are optionally generally perpendicular to the base wall **454**, as is shown in the illustrated embodiment (other angles such as oblique angles may be provided in other embodiments). In the illustrated embodiment, the bottom of each header ground shield **122** is open between the side walls **452** and **456**. Either the header ground shield **122** associated with another pair of header signal contacts **120** or the orphan ground shield **400** (not shown in FIGS. 6 and 8) provides shielding along the open, fourth side such that each of the pairs of header signal contacts **120** is shielded from each adjacent pair in the same column C (described below; not shown in FIGS. 6 and 7) and the same row R (described below; not shown in FIGS. 6 and 7).

The header ground shields **122** may be provided with other configurations, sizes, shapes, and/or the like in other embodiments. The header ground shields **122** may be provided with more or less (i.e., any number of) walls in other embodiments. The walls of the header ground shield **122** may be bent or angled rather than being planar. In some other embodiments, the header ground shields **122** may provide shielding for individual header signal contacts **120** or sets of contacts having more than two header signal contacts **120**.

The header ground shield **122** includes one or more interference bumps **462** formed in the walls **452**, **454**, and/or **456**. The interference bumps **462** engage the header housing **110** (not shown in FIGS. 6 and 7), such as inside the ground shield opening **406** (not shown in FIGS. 6 and 7), to hold the header ground shield **122** in the ground shield opening **406** by an interference fit.

In the illustrated embodiment of the header ground shields **122**, the various structures (e.g., the first mating end **442**, the second mating end **444**, the side wall **452**, the base wall **454**, and/or the side wall **456**) of each of the header ground shields **122** are integrally formed as a single, unitary structure. Alternatively, one or more of the various structures of a header ground shield **122** is separately (i.e., discretely) formed as a separate (i.e., discrete) structure from one or more other structures of the header ground shield **122**.

FIG. 8 is a perspective view of the header transition connector **102** illustrating a cross section of the header transition connector **102**. The header ground shields **122** optionally extend an entire length of the header signal contacts **120** from the tip of the first mating end **422** to the tip of the second mating end **424**, as is shown in FIG. 8. Optionally, because the first receptacle connector **104** (shown in FIGS. 1, 2, 11, and 12) or the second receptacle connector **106** (shown in FIGS. 1, 2, 11, and 12) is securely coupled to the header transition connector **102** as a header assembly **500** (shown in and described below with respect to FIG. 12), the first mating ends **422** of the header signal

13

contacts 120 and the first mating ends 442 of the header ground shields 122 do not have the same mating and unmating requirements and built-in tolerances as the second mating ends 424 and 444. As such, the first mating ends 422 of the header signal contacts 120 may be shorter than the second mating ends 424 of the header signal contacts 120, and the first mating ends 442 of the header ground shields 122 may be shorter than the second mating ends 444 of the header ground shields 122, which may result in a reduction in the amount of materials used to manufacture (i.e., fabricate) the electrical connector system 100 (shown in FIGS. 1, 11, and 12). The amount of plating (e.g., gold plating) may be reduced. The amount of electrical stub may be reduced.

Referring again to FIG. 4, in the illustrated embodiment, the first mating ends 422 of the header signal contacts 120 are arranged within the cavity 116 in an array of the rows R and the columns C. In the illustrated embodiment, the header signal contacts 120 within each pair are arranged in the same column C. The second mating ends 424 (FIG. 5) of the header signal contacts 120 are arranged within the cavity 118 (shown in FIGS. 1, 4, 5, and 12) in an array of the rows R and the columns C in a substantially similar (e.g., identical, matching, mirrored, and/or the like) manner to the arrangement described above and illustrated in FIG. 4 with respect to the first mating ends 422.

In the illustrated embodiment, the first mating ends 442 (FIG. 5) of the header ground shields 122 are arranged within the cavity 116 in an array of the rows R and the columns C. The second mating ends 444 of the header ground shields 122 are arranged within the cavity 118 in an array of the rows R and the columns C in a substantially similar (e.g., identical, matching, mirrored, and/or the like) manner to the arrangement described above and illustrated in FIG. 4 with respect to the first mating ends 442.

Although ten rows R are shown, the header transition connector 102 may include any number of the rows R to correspond with the number of rows of the first and second receptacle connectors 104 and 106 (FIG. 1). Although six columns C are shown, the header transition connector 102 may include any number of the columns C to correspond with the number of columns of the first and second receptacle connectors 104 and 106 (FIG. 1). Each of the rows R may be referred to herein as a “first” and/or an “other” row. Each of the columns C may be referred to herein as a “first” and/or an “other” column.

Referring again to FIGS. 6 and 7, the header ground shield 122 optionally includes one or more spring arms 480. Each spring arm 480 is configured to engage in physical contact with an adjacent header ground shield 122 within the same column C (FIG. 4) to electrically common the two adjacent header ground shields 122 within the column C. In the illustrated embodiment, each spring arm 480 extends outward from the base wall 454. Each spring arm 480 extends outward to an end 482 having an engagement surface 484. Each spring arm 480 is configured to engage in physical contact with the adjacent header ground shield 122 within the same column C at the engagement surface 484.

In the illustrated embodiment, the end 482 of each spring arm 480 is resiliently deflectable along an arc B in the direction D from the natural resting position of the spring arm 480 shown in FIGS. 6 and 7. The resilience of the spring arm 480 (i.e., the bias of the end 482 of the spring arm 480 to the natural resting position thereof) generates an engagement force between the engagement surface 484 and the adjacent header ground shield 122 within the same column C to provide a reliable engagement and thus electrical connection between the two header ground shields 122.

14

Although two spring arms 480 are shown, each header ground shield 122 may include any number of the spring arms 480 for engaging in physical contact with any number of other header ground shields 122. Moreover, each spring arm 480 may alternatively have any other location(s) along the header ground shield 122 than the locations shown herein.

The header ground shield 122 optionally includes one or more tabs 460. Each tab 460 is configured to engage in physical contact with the spring arm 480 of an adjacent header ground shield 122 within the same column C to electrically common the two adjacent header ground shields 122 within the column C. In the illustrated embodiment, each tab 460 extends outward from a corresponding side wall 452 or 456 at a respective end 464 or 466 thereof. Each tab 460 extends outward to an engagement surface 468. Each tab 460 is configured to engage in physical contact with the spring arm 480 of the adjacent header ground shield 122 within the same column C at the engagement surface 468. The ends 464 and 466 of the side walls 452 and 456 include the engagement surface 468 of the corresponding tab 460.

Although two tabs 460 are shown, each header ground shield 122 may include any number of the tabs 460 for engaging in physical contact with any number of locations on other header ground shields 122. Moreover, each tab 460 may additionally or alternatively have any other location(s) along the header ground shield 122 than the locations shown herein.

Optionally, the tabs 460 are used to stop or locate the header ground shield 122 in the ground shield opening 406 (shown in FIGS. 4 and 5), for example to limit the amount that the header ground shield 122 is loaded into the ground shield opening 406. The tabs 460 may define push surfaces for pushing or loading the header ground shield 122 into the ground shield opening 406. Optionally, the first receptacle connector 104 (shown in FIGS. 1, 2, 11, and 12) or the second receptacle connector 106 (shown in FIGS. 1, 3, 11, and 12) may be positioned immediately behind the tabs 460 when loaded into the first cavity 116 (shown in FIGS. 1, 4, 5, 11, and 12) to block the header ground shield 122 from being pushed out of the ground shield opening 406, for example when the other receptacle connector 104 or 106 is loaded into the second cavity 118 (shown in FIGS. 1, 4, 5, and 12).

Optionally, the header ground shield 122 includes one or more spring arms 486 configured to engage in physical contact with an adjacent header ground shield 122 within the same row R (FIG. 4) to electrically common the two adjacent header ground shields 122 within the row R. In the illustrated embodiment, the spring arm 486 extends outward from the first side wall 452. The spring arm 486 extends outward to an end 488 having an engagement surface 490. The spring arm 486 is configured to engage in physical contact with the adjacent header ground shield 122 within the same row R at the engagement surface 490.

In the illustrated embodiment, the end 488 of each spring arm 486 is resiliently deflectable along an arc E in the direction F from the natural resting position of the spring arm 486 shown in FIGS. 6 and 7. The resilience of the spring arm 486 (i.e., the bias of the end 488 of the spring arm 486 to the natural resting position thereof) generates an engagement force between the engagement surface 490 and the adjacent header ground shield 122 within the same row R to provide a reliable engagement and thus electrical connection between the two header ground shields 122.

15

Each header ground shield **122** may include any number of the spring arms **486** for engaging in physical contact with one or more other header ground shields **122**. In the illustrated embodiment, the header ground shield **122** includes only a single spring arm **486**. The spring arm **486** may alternatively have any other location(s) along the header ground shield **122** than the location shown herein.

In some other embodiments, the header ground shield **122** does not include any of the spring arms **486** such that the header ground shield **122** is not configured to be engaged in physical contact (and thus not electrically commoned with) adjacent header ground shields **122** within the same row **R**. Moreover, in some other embodiments, the header ground shield **122** does not include any of the spring arms **480** such that the header ground shield **122** is not configured to be engaged in physical contact (and thus not electrically commoned with) adjacent header ground shields **122** within the same column **C**.

Referring again to FIG. 4, at least some of the header ground shields **122** are electrically commoned with each other within the header housing **110** of the header transition connector **102**. For example, a group of the header ground shields **122** may be electrically commoned with each other within the header housing **110**. Electrically commoning at least some of the header ground shields **122** within the header housing **110** may provide an electrical connector system **100** that mates the receptacle connectors **104** and **106** together without a midplane circuit board but that behaves electrically as if a midplane circuit board is present. Electrically commoning at least some of the header ground shields **122** within the header housing **110** may enable the header transition connector **102** to cancel and/or reduce signal noise, to improve inter-pair signal skew, to match and/or provide a predetermined impedance, and/or the like. The header ground shields **122** within the group are electrically commoned within the header housing **110** via engagement of the header ground shields **122** so as to provide a continuous electrical pathway from any one header ground shield **122** of the group to all other header ground shields **122** of the group, as will be specifically described below with respect to the illustrated embodiment.

The group of the header ground shields **122** that are electrically commoned may include any number of the overall number of header ground shields **122**. In some embodiments, the group of the header ground shields **122** that are electrically commoned includes all of the header ground shields **122** of the header transition connector **102**. Moreover, any particular header ground shields **122** may be included within the group of header ground shields **122** that are electrically commoned within the header housing **110**. The number of and particular header ground shields **122** within the group of electrically commoned header ground shields **122**, as well as the pattern, configuration, relative arrangement, and/or the like of the group of electrically commoned header ground shields **122**, may be selected to provide the header transition connector **102** with a predetermined electrical performance (e.g., to cancel and/or reduce signal noise, to improve signal skew, to match and/or provide a predetermined impedance, and/or the like).

FIG. 9 is an elevational view of a portion of the header transition connector **102**. Referring now to FIGS. 4, 8, and 9, in the illustrated embodiment, within each column **C**, the spring arms **480** of the header ground shields **122** are engaged in physical contact with the tabs **460** of adjacent header ground shields **122** within the same column **C**. Specifically, and referring now solely to FIGS. 8 and 9, within each column **C**, the engagement surfaces **484** of the

16

spring arms **480** are engaged in physical contact with the engagement surfaces **468** of the corresponding tabs **460** of adjacent header ground shields **122** within the same column **C**. The engagement in physical contact of the engagement surfaces **484** and **468** electrically connects adjacent header ground shields **122** within the same column **C** such that at least some of the header ground shields **122** within the column **C** are electrically commoned together.

Referring again to FIG. 4, any number, and any particular ones, of the header ground shields **122** within each column **C** may be electrically commoned. In the illustrated embodiment, all of the header ground shields **122** within each column **C** (excepting the orphan ground shields **400**) are electrically commoned. In some other embodiments, the orphan ground shield **400** of one or more columns **C** is electrically commoned with one or more other header ground shields **122** of the same column **C**, for example using a similar structure to the spring arms **480** and/or the tabs **460** and/or using another structure.

Any number, and any particular ones, of the columns **C** may include header ground shields **122** that are electrically commoned. In the illustrated embodiment, all of the columns **C** include header ground shields **122** that are electrically commoned.

In the illustrated embodiment, within each row **R**, the spring arms **486** of the header ground shields **122** are engaged in physical contact with the side walls **456** of adjacent header ground shields **122** within the same row **R**. Specifically, and referring now to FIG. 10, within each row **R**, the engagement surfaces **490** of the springs arms **486** are engaged in physical contact with the side walls **456** of adjacent header ground shields **122** within the same row **R**. The engagement in physical contact of the spring arms **486** and the side walls **456** electrically connects adjacent header ground shields **122** within the same row **R** such that at least some of the header ground shields **122** within the row **R** are electrically commoned.

Referring again to FIG. 4, any number, and any particular ones, of the header ground shields **122** within each row **R** may be electrically commoned. In the illustrated embodiment, all of the header ground shields **122** within each row **R** are electrically commoned. Any number, and any particular ones, of the rows **R** may include header ground shields **122** that are electrically commoned. In the illustrated embodiment, all of the rows **R** include header ground shields **122** that are electrically commoned. In some other embodiments, two or more of the orphan ground shields **400** within the row **R** of the orphan ground shields **400** are electrically commoned, for example using a similar structure to the spring arms **486** and/or using another structure.

Although the illustrated embodiment includes both header ground shields **122** electrically commoned within the same column **C** and header ground shields **122** electrically commoned within the same row **R**, the header transition connector **102** is not limited thereto. For example, in some other embodiments, the header transition connector **102** only includes electrically-commoned header ground shields **122** within one or more columns **C** (i.e., does not include any header ground shields **122** that are electrically commoned with one or more other header ground shields **122** within the same row **R**). Electrically commoning the header ground shields **122** only within the columns **C** may provide the header transition connector **102** with a substantially similar electrical performance as compared with also electrically commoning header ground shields **122** within the same row(s) **R**. In other words, electrically commoning the header ground shields **122** within the rows **R** may not provide a

17

noticeable, substantial, and/or more than trivial improvement in the electrical performance of the header transition connector **102**.

FIG. **11** illustrates the header transition connector **102** poised for mating with the first receptacle connector **104**. The header transition connector **102** is loaded in a loading direction **A**. The first receptacle connector **104** is configured to be received in the first cavity **116**. Optionally, securing features may be provided to securely couple the header transition connector **102** to the first receptacle connector **104**. Guide features may be provided to guide mating.

FIG. **12** is a front perspective view of the header transition connector **102** coupled to the first receptacle connector **104** to form the header assembly **500**. The header signal contacts **120** are arranged in an array in the rows **R** and columns **C** having a pinout that is complementary to the pinout of the receptacle signal contacts **142** (shown in FIGS. **1** and **2**) and **162** (shown in FIGS. **1** and **3**) of the first and second receptacle connectors **104** (shown in FIGS. **1**, **2**, **11**, and **12**) and **106** (shown in FIGS. **1**, **3**, **11**, and **12**), respectively. For example, the pinouts are defined by the horizontal and vertical spacings between the corresponding signal contacts **120**, **142**, and **162** (for example, the centerline spacings) and the horizontal and vertical spacings from the signal contacts **120**, **142**, and **162** to the header ground shields **122** (for example, the centerline spacings). Optionally, the pinouts of the header transition connector **102** are complementary, matching, identical, and/or the like to the pinouts of the receptacle connectors **104** and **106** to allow mating and interchangeability of the receptacle connectors **104** and **106** into either cavity **116** or **118** of the header transition connector **102**. In other words, the pinouts of the header transition connector **102** may be configured relative to the pinouts defined by the receptacle connectors **104** and **106** such that the receptacle connectors **104** and **106** are interchangeable and configured to be mated to either end **112** or **114** of the header transition connector **102**.

In an exemplary embodiment, the header transition connector **102** is coupled to the first receptacle connector **104** prior to mating with the second receptacle connector **106**. Optionally, the header assembly **500** may form part of an electrical system, such as, but not limited to, a backplane, a network switch, a computer server, and/or the like, where many header assemblies **500** are arranged together, such as, but not limited to, inside a chassis, rack, and/or the like. One or more second receptacle connectors **106** may be coupled to the header assemblies **500** as part of line and/or switch cards. The header transition connector **102**, by being coupled directly to the first receptacle connector **104**, enables mating of the second receptacle connector **106** to the first receptacle connector **104** without the need for a midplane circuit board, and vice versa. The header transition connector **102** changes the mating interface of the first receptacle connector **104** from a receptacle interface to a pin interface for mating with the second receptacle connector **106**, and vice versa.

The embodiments described and/or illustrated herein may provide an improved electrical connector system for mating receptacle connectors without a midplane circuit board.

For example, the embodiments described and/or illustrated herein may provide an electrical connector system that mates receptacle connectors together without a midplane circuit board but that behaves electrically (e.g., from a signal integrity perspective) as if a midplane circuit board is present. Moreover, and for example, the embodiments described and/or illustrated herein may cancel signal noise generated when passing an array of signals between recep-

18

tacle connectors without a midplane circuit board. The embodiments described and/or illustrated herein may provide an electrical connector system having reduced signal noise as compared to at least some known electrical connector systems that mate receptacle connectors together without a midplane circuit board, for example. Moreover, and for example, the embodiments described and/or illustrated herein may improve inter-pair signal skew when passing an array of signals between receptacle connectors without a midplane circuit board, for example. The embodiments described and/or illustrated herein may provide an electrical connector system having improved signal skew as compared to at least some known electrical connector systems that mate receptacle connectors together without a midplane circuit board, for example.

The embodiments described and/or illustrated herein may provide an electrical connector system having improved signal skew as compared to at least some known electrical connector systems that mate receptacle connectors together with a midplane circuit board.

The embodiments described and/or illustrated herein may provide an electrical connector system having a reduced cost and/or a reduced size as compared to at least some known electrical connector systems for mating receptacle connectors. For example, the embodiments described and/or illustrated herein may provide an electrical connector system that has a reduced cost as compared to at least some known electrical connector systems that mate receptacle connectors together with a midplane circuit board and/or as compared to at least some known electrical connector systems that mate receptacle connectors together without a midplane circuit board. Moreover, and for example, the embodiments described and/or illustrated herein may provide an electrical connector system that mates receptacle connectors together without a midplane circuit board with: (1) a reduced cost as compared to at least some known electrical connector systems that mate receptacle connectors together with a midplane circuit board; and (2) the electrical performance of a midplane circuit board.

It is to be understood that the above description is intended to be illustrative, and not restrictive. For example, the above-described embodiments (and/or aspects thereof) may be used in combination with each other. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from its scope. Dimensions, types of materials, orientations of the various components, and the number and positions of the various components described herein are intended to define parameters of certain embodiments, and are by no means limiting and are merely exemplary embodiments. Many other embodiments and modifications within the spirit and scope of the claims will be apparent to those of skill in the art upon reviewing the above description. The scope of the invention should, therefore, be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled. In the appended claims, the terms “including” and “in which” are used as the plain-English equivalents of the respective terms “comprising” and “wherein.” Moreover, in the following claims, the terms “first,” “second,” and “third,” etc. are used merely as labels, and are not intended to impose numerical requirements on their objects. Further, the limitations of the following claims are not written in means-plus-function format and are not intended to be interpreted based on 35 U.S.C. §112(f), unless and until such claim limitations expressly use the phrase “means for” followed by a statement of function void of further structure.

What is claimed is:

1. A header transition connector comprising:
a header housing having a separating wall separating a first cavity from a second cavity;
header signal contacts held by the header housing, the header signal contacts arranged in pairs carrying differential signals, the header signal contacts having first mating ends in the first cavity for mating with a first receptacle connector, the header signal contacts having second mating ends in the second cavity for mating with a second receptacle connector; and
header ground shields held by the header housing, the header ground shields having walls surrounding associated pairs of header signal contacts on at least two sides thereof, the header ground shields having first mating ends in the first cavity for mating with the first receptacle connector, the header ground shields having second mating ends in the second cavity for mating with the second receptacle connector, the header ground shield comprising an engagement feature integral with the corresponding header ground shield, the engagement feature having an engagement surface, wherein at least a group of the header ground shields are electrically commoned via engagement of the engagement feature in physical contact at the engagement surface with at least one other header ground shield of the group within the header housing.
2. The header transition connector of claim 1, wherein the header ground shields are arranged in an array of rows and columns, the group of header ground shields comprising header ground shields within a first column of the columns.
3. The header transition connector of claim 1, wherein the header ground shields are arranged in an array of rows and columns, the group of header ground shields comprising header ground shields within a first row of the rows.
4. The header transition connector of claim 1, wherein the header ground shields are arranged in an array of rows and columns, the group of header ground shields comprising header ground shields within a first column of the columns, at least some of the header ground shields of each other column being electrically commoned with at least some of the other header ground shields of the same column.
5. The header transition connector of claim 1, wherein the header ground shields are arranged in an array of rows and columns, the group of header ground shields comprising header ground shields within a first column of the columns, at least some of the header ground shields of each other column being electrically commoned with at least some of the other header ground shields of the same column, at least some of the header ground shields of each row being electrically commoned with at least some of the other header ground shields of the same row.
6. The header transition connector of claim 1, wherein the header ground shields are arranged in an array of rows and columns, the group of header ground shields comprising header ground shields within a first column of the columns, the header ground shields of the group being electrically commoned with each other via engagement in physical contact with another header ground shield of the group that is adjacent within the first column.
7. The header transition connector of claim 1, wherein the engagement feature is a spring arm that is engaged in physical contact with another header ground shield of the group to electrically common the header ground shields of the group.
8. The header transition connector of claim 1, wherein the engagement feature is a tab that is engaged in physical

contact with another header ground shield of the group to electrically common the header ground shields of the group.

9. The header transition connector of claim 1, wherein the walls of the header ground shields comprise base walls and side walls that extend from the base walls, the engagement feature extends from the base wall and is engaged in physical contact with an end of a side wall of another header ground shield of the group to electrically common the header ground shields of the group.

10. The header transition connector of claim 1, wherein the header ground shields are C-shaped.

11. The header transition connector of claim 1, wherein the walls of the header ground shield comprise a base wall and a side wall that extends from the base wall, the base wall spanning across both header signal contacts of the corresponding pair of header signal contacts.

12. The header transition connector of claim 1, wherein the header ground shield is a stamped and formed structure, the engagement feature is formed from the header ground shield.

13. A header transition connector comprising:

a header housing having a separating wall separating a first cavity from a second cavity;

header signal contacts held by the header housing, the header signal contacts arranged in pairs carrying differential signals, the header signal contacts having first mating ends in the first cavity for mating with a first receptacle connector, the header signal contacts having second mating ends in the second cavity for mating with a second receptacle connector; and

header ground shields held by the header housing, the header ground shields having walls surrounding associated pairs of header signal contacts on at least two sides thereof, the header ground shields having first mating ends in the first cavity for mating with the first receptacle connector, the header ground shields having second mating ends in the second cavity for mating with the second receptacle connector, the header ground shield comprising an engagement feature integral with the corresponding header ground shield, the engagement feature having an engagement surface, wherein the engagement feature of a first header ground shield is engaged in physical contact at the engagement surface with a second header ground shields such that the first and second header ground shields are electrically connected together.

14. The header transition connector of claim 13, wherein the header ground shields are arranged in an array of rows and columns, the first and second header ground shields being arranged within the same column.

15. The header transition connector of claim 13, wherein the header ground shields are arranged in an array of rows and columns, the first and second header ground shields being arranged adjacent to each other within the same column.

16. The header transition connector of claim 13, wherein the header ground shields are arranged in an array of rows and columns, the first and second header ground shields being arranged within a first column of the columns, at least some of the header ground shields of the first column being electrically commoned with each other within the header housing.

17. The header transition connector of claim 13, wherein engagement feature is a spring arm that is engaged in physical contact with the second header ground shield to electrically connect the first and second header ground shields.

21

18. The header transition connector of claim 13, wherein the engagement feature is a tab that is engaged in physical contact with the second header ground shield to electrically connect the first and second header ground shields.

19. The header transition connector of claim 13, wherein 5
the walls of the header ground shields comprise base walls and side walls that extend from the base walls, the engagement feature extends from the base wall and is engaged in physical contact with an end of a side wall of the second header ground shield to electrically connect the first and 10
second header ground shields.

20. The header transition connector of claim 13, wherein the header ground shield is a stamped and formed structure, the engagement feature is formed from the header ground 15
shield.

21. An electrical connector system comprising:
a receptacle connector comprising receptacle signal con-
tacts arranged in pairs carrying differential signals, the
receptacle connector comprising a ground shield hav- 20
ing ground contacts extending therefrom; and
a header transition connector coupled to the receptacle
connector, the header transition connector comprising a
header housing holding header signal contacts and
header ground shields, the header housing having a

22

separating wall separating a first cavity from a second
cavity, the receptacle connector configured to be
received in the first cavity, the header signal contacts
arranged in pairs carrying differential signals, the
header signal contacts having first mating ends that
extend in the first cavity and are configured to be mated
with the receptacle signal contacts of the receptacle
connector, the header signal contacts having second
mating ends that extend in the second cavity for mating
with a second receptacle connector, the header ground
shields having first mating ends in the first cavity for
mating with the ground contacts of the receptacle
connector, the header ground shields having second
mating ends in the second cavity for mating with the
second receptacle connector, the header ground shield
comprising an engagement feature integral with the
corresponding header ground shield, the engagement
feature having an engagement surface, wherein the
engagement feature of a first header ground shield is
engaged in physical contact at the engagement surface
with a second header ground shield such that the first
and second header ground shields are electrically con-
nected together.

* * * * *